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ABSTRACT

This report on the influence of emotional factors on cognitive processes and their importance to the design of man-machine systems intended to function under conditions of threat reviews the literature on stress and human performance, coping strategies, emotion theory, and individual differences in response to stress. A framework for relating emotions to motivation is outlined and preliminary implications for the design of man-machine systems are discussed. More than 230 references are listed. (Author/FM)

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THE INFLUENCE OF EMOTIONS ON INFORMATION PROCESSING

Lars-Olof Persson & Lennart Sjöberg

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Abstract

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Abstract. - This is a review of the influence of emotions on cognitive processes. Such influence is of theoretical importance and practically of interest, particularly in the design of man-machine systems intended to function under conditions of threat. The report reviews work on stress and performance, coping strategies, emotion theory, and individual differences in response to stress. One common theme in much of this work is the narrowing of attention under emotional stress. Another is a recourse to more primitive and heuristic levels of functioning. A framework for relating emotions to motivation is outlined and preliminary implications for the design of man-machine systems are discussed.

Key words: emotion, stress, emotion-cognition interaction, man-machine systems.

1. Introduction

Man-machine systems often require the efficient use of complex cognitive processes, both for various types of cognitive achievement and for decision making. Furthermore, these functions must sometimes be performed under time pressure and emotional stress. The most extreme example of emotional stress may be found in the situation of the operator in various man-machine systems in military applications.

Cognition and perception have most often been studied in situations assumed to be neutral from an emotional point of view. The findings are then extrapolated to applied situations where various types of emotional factors may have an influence. It is of course possible that an optimal design of a man-machine system based on experimental findings in neutral laboratory situations (or laboratory simulations of natural contexts) may still be optimal in realistic applications. However, this is an asumption that one may want to question. A striking example of the effect of danger on human performance is discussed by Baddeley (1972), who reviewed work on performance in highly dangerous situations indicating a narrowing of attention. A interesting example of the effect of stress is offered by Walker and Burkhardt (1965) who pointed to large differences in performance in aircraft weapons system under high degrees of combat stress but negligible differences under neutral conditions. A quite different example is offered by Oliver and Griffit (1976), who studied judgments made in a legal context under emotional arousal due to highly naturalistic picture showing injuries done to victims. They established the

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difficulties that judges have in separating objective information from the emotional impression made by the provocative pictures.

Montgomery and Svenson (1976) suggested a hierarchy of decision rules going from simple and little demanding rules to more complex rules that were supposed to require more of attention or energy in order to be applied. Sjöberg and Johnson (1978) suggested that people under emotional stress need to invest more of their total energy resources into the orderly processing of action than what is required under normal circumstances, and this in turn makes the cognitive system weaker and more primitive. These ideas fit well with the suggestions by Montgomery and Svenson in the particular area of decision making. One would expect more simple and coarse rules to be applied under emotional stress due to a lack of cognitive resources. Another factor of importance is of course the decision criteria applied under acute emotional stress. This in turn brings in the value system of the individual, which is normally applied in attempts to regulate action under the influence of emotional disturbances. Examples of the difficulties of regulating action under such conditions are given in studies by failures to carry through decisions in the field of addictive behavior (Sjöberg & Johnson; Sjöberg & Persson, 1977; Sjöberg & Samsonowitz, 1977; Sjöberg, Samsonowitz & Olsson, 1978). In these studies it was found that people tend to fail in carrying through their intentions to fight their addictions, particularly when they are under emotional stress, and that their failures are preceded by distorted reasoning recognized as distorted both by themselves and by others in retrospect.

The purpose of this report is to review work on the emotional influence on cognitive process in order to come up with theoretical and empirical generalizations that could be useful in further empirical work on man-machine systems. We wish to stress at this initial point that our interest is mostly concerned with the interaction of emotion and cognition. The literature is, however, dominated by studies of the relation between stress and performance. Naturally, such studies are informative to some extent in relation to our total interest, but they are concerned more with relations between overt variables of the stimulus and response kind than with the covert mental processes that are in the focus of interest for us. In particular we want to stress the need for structuring the field into two categories that possibly may be quite different from a psychological point of view. First, there is the question of how various types of cognitive skills are influenced by emotional stress. Second, there is the question of how decision criteria and values are changed by emotional stress and how values are utilized or not utilized in the regulation of action under emotional stress.

The report starts with a review of emotions and of stress and performance. Some attention is also paid to individual differences in emotional response. A general frame of reference for the emotional process is finally offered and implications for further work on man-machine systems are finally discussed.

2. Emotions: A brief review

2.1 Introduction

The study of emotions is one of the most diversified and comples fields included in psychological research. There is a wide range from philosophical speculations to the most detailed neurophysiological studies, all with the same aim to described and explain emotional processes in the organism, but with different starting points. Some theorists stress the dimensions of feelings, moods or emotions, like Nowlis & Nowlis (1956), McNair, Lorr and Droppleman (1971), and Sjöberg, Svensson and Persson (1978). Others are more interested in emotional behavior (Watson, 1929; Millenson, 1967) or the different emotional expressions (Darwin, 1972; Davitz, 1969; Frijda, 1970). Still others emphasize the cognitive aspects of emotions (Lazarus, 1966; Arnold, 1970; Schacter & Singer, 1962), or the developmental (Bridges, 1932) or physiological aspects (Lindsley, 1951; Ax, 1953). In short, this list could be made exhaustive in describing all the different starting points and directions in research on emotions. And the picture becomes even more confusing when considering all the different viewpoints included in any specialized direction. Therefore we shall content ourselves, in this chapter, to discuss some central points, regarded as important in discussing emotions. The reader is referred to Arnold (1970), Strongman (1973), Mandler (1975) or Izard (1977) for more thorough discussions of the psychology of emotions.

2.2 Physiological basis of emotions

One of the fundamental aspects of emotions is the existence of concomitant physiological changes in the organism. This fact has been particularly emphasized in the modern research due to the well known James-Lange theory (James, 1884). In a way this theory turned earlier thinking on emotions upside down in suggesting that the emotional feeling is subsequent to visceral discharge, that we feel sad because we have been crying, not that we cry because we feel sad. James, particularly, emphasized the visceral changes and he based the theory largely on introspection. The critique of the James-Lange theory did not wait long, however, and was best formulated by Cannon (1927), who stressed that: (a) Emotional behavior is still present when the viscera are separated from the central nervous system, i.e. in cases of sympathectomy or vagotomy. (b) Visceral changes do not seem to differ from emotion to emotion. (c) The viscera are insensitive, i.e. feedback from visceral response is diffuse and indistinct and could not serve as the basis for differentiating emotion. (d) Visceral changes are relatively slow and their speed would predict that emotion could not occur in less than one to two seconds following stimulation. Introspective evidence contradicted such long latencies. (e) Production of visceral changes by artificial means, for example by drugs, does not seem to produce emotions.

Though Cannon's critique is still valid, some recent studies have shown that visceral changes play important roles in emotional processes, particularly via the activity of the sympathetic nervous system. For example, Hohmann (1966) reported that subjects with spinal cord lesions separating visceral organs from the CNS, reported decreased feelings of anger, sex and fear. Typical comments were for example: "I used to have a hot temper but now it's nothing compared to what it was ... seems like I get thinking mad, not shaking mad, and that's a lot different". "Now, I don't get a feeling of physical animation, it's sort of cold anger". (Hohmann, 1966, p. 151). The possibility of peripheral differences during different emotional states has been studied, so far without any real success, but Wolf and Wolff (1947) found that there were two types of gastric change with emotional disturbance. There was a reduction in the output of acid vascularity and gastric motility. With reported anxietv and the wish to escape there was an acceleration of gastric function with reported anger and resentment. Ax (1953) found a rise in diastolic blood ~~pressure,~~ muscle potential and the number of increases in skin conductance and a decrease in heart rate when subjects were angry. In a fear condition the changes were not so extreme and the decrease in heart rate did not occur. Also, skin conductance and respiration rate both rose more in the fear condition. He concluded that the fear pattern was similar to that which follows an adrenalin injection and anger like that which follows a noradrenalin injection. However, there has been a lack of confirmatory research subsequent to the two last mentioned studies.

Further studies, which suggest that perceptions of bodily changes are important to emotional reactions are, for example, those performed by Valins (Valins, 1966, 1970). He led subjects to believe that their heart rates were recorded and heard through some very old equipment, while they rated the attractiveness of nude females. In fact the subjects heard prerecorded heart beat that were varied by the experimenter during the presentations. Results showed that nudes to which subjects had heard their heart rate change were liked more than others.

The question is, however, to what extent real feedback is similar to simulated feedback such as the one used in these studies. According to Strongman (1973) it should not be forgotten that much of the work involving peripheral changes and emotions may involve no more than a vague reflection of general arousal.

The concept of arousal was particularly emphasized in connection with emotions in neurophysiological terms by Lindsley (1970) and in behavioral terms by Duffy (1962). Lindsley proposed that arousal, as measured by EEG, underlies emotions, and particularly the interaction between the brain-stem reticular formation and the limbic systems via the ascending reticular activating system. Duffy, on the other hand, argued that the term emotion should be abandoned as a concept in scientific research. As a consequence of this she broke down emotions into changes of energy level (arousal), organizational versus disorganizational, and suggested that each of these changes occurs on a continuum. There are still many others who have tried to describe and explain emotions in neurophysiological or neuroanatomical terms, like Arnold (1970), Stanley-Jones (1970) and Gellhorn (1964) but it is sufficient to conclude here that emotional experiences include neurophysiological changes such as increased sympathetic activity and general arousal.

2.3 Emotions and cognitive interpretation

The concept of arousal is insufficient to explain all the different nuances of human emotions. This fact has led several reseachers, like Schacter and Singer (1962), Lazarus (1966) and Arnold (1970) to propose that cognitions or appraisals of external, environmental cues are necessary to combine with the more diffuse physiological reactions, thus generating the wide diversity of emotions. The ingenious studies performed by Schacter and co-workers (Schacter & Singer, 1962; Schacter, 1970) have very clearly shown the appropriatiness of these ideas. In this first, and probably most important, experiment, Schacter led his subjects to believe that the experimenters were interested in the effects of a special vitamin on vision. In fact, they were injected with adrenalin in order to mimic symphathetic activity, and a placebo. Some subjects were informed about the effects of the drug, others were not. Furthermore, the experimenters induced two emotional states in the subjects, via social manipulation, euphoria and anger. By observational and selfreport data the results showed that subjects were significantly more euphoric or angry when they were given no explanation of their bodily states. Schachter and Singer concluded from these results ~~that~~ they had managed to manipulate, via cognitions, the feelings of someone physiologically aroused, but with no explanation for his arousal. This means that there may indeed be very little physiological differentiation between physiological states (i.e., euphoria and anger). How we label such states may be largely a cognitive matter. Further support for the proposal that emotional experiences result from interactions of internal and external cues is given by the studies by Valins and co-workers, referred to earlier, and Nowlis and co-workers (Nowlis & Nowlis, 1956; Nowlis, 1963; Nowlis, 1970). Nowlis demonstrated in his work with drugs and the mood adjective check list (MACL) that mood was dependent on an interaction between internal factors (manipulated by drugs) and the external factors (the tasks being performed and the behavior of the other people in the situation).

What, then, does cognitive interpretation mean? According to Arnold (1970), who prefers to speak in terms of appraisals; an emotion is "a felt tendency toward anything appraised as good, and away from anything appraised as bad" (Arnold, 1970, p. 176). This means that these appraisals are evaluations of the personal impact of any incoming information. We appraise any stimulus as to whether it is good or bad for us, i.e. a felt tendency what to approach or avoid. Thus, in this way emotions are meaningful in initiating and reducing action tendencies. Rather similar to the views of Arnold are those by Pribram (1970). According to him behavior is organized via the construction and implementations of plans (Miller, Galanter & Pribram, 1960). These plans may be very easily executed, or they may fail. We evaluate or appriase their success, and this process of appraisal is monitored, i.e. it is subjectively felt.

Thus, so far it seems to exist clear evidences that an interaction between physiological arousal and cognitive interpretations is essential in shaping the specific emotional experiences.

2.4 Classification and description of emotions

Let us now turn to another question important in the research of emotions, namely the classificational problems of emotions. Looking in a word list it is possible to find hundreds of adjectives denoting different emotional states. It is very natural, then, to search for possibilities to reduce emotions into more basic dimensions. The work by Plutchik (Plutchik, 1970), Nowlis (Nowlis & Nowlis, 1956; Nowlis, 1963; Nowlis, 1970) and Sjöberg, Svensson and Persson (1978) are examples of these strivings for simplicity. Beginning with the views of Plutschik, he argued that emotions vary in three systematic ways: intensity, similarity and polarity. Furthermore he argued that emotions can be described in terms of different languages: the subjective, the behavioral, and the functional (see Table 2.1).

Table 2.1

The three languages used to describe emotional states, according to Plutchik (from Plutchik, 1970, p. 11).

	Subjective	Behavioral	Functional
(1)	Fear, terror	Escaping	Protection
(2)	Anger, rage	Attacking	Destruction
(3)	Joy, ecstasy	Mating	Reproduction
(4)	Sadness, grief	Losing contact	Deprivation
(5)	Acceptance, greed	Eating	Incorporation
(6)	Disgust, loathing	Vomiting, defecating	Rejection
(7)	Expectancy, watchfulness	Sensing	Exploration
(8)	Surprise, astonishment	Stopping	Orientation

Plutchik maintained that we normally use the everyday, subjective language, but that these terms have behavioral and functional correlates as well. Note that emotions in Plutchik's view thus have an adaptive function for the organism. Nowlis, on the other hand, did not have such a wide ambition as Plutchik. Rather, he simply postulated four bipolar dimensions, namely: Pleasantness/unpleasantness, activation/deactivation, positive/negative social orientation, control/lack of control. However, in factor analyzing self reports on adjective checklist he obtained as much as 12 unipolar dimensions which then constituted his widely used mood adjective checklist. Subsequent studies by Meddis (Meddis, 1972) and Sjöberg, Svensson and Persson (1978) showed, however, that the results of Nowlis are probably due to methodological fallacies. In fact, when these fallacies were taken care of, six bipolar factors were obtained: Pleasantness/unpleasantness, activation/deactivation, extraversion/introversion, calmness/tension, positive/negative social orientation, control/lack of control. However, the dimensions of pleasantness/unpleasantness and activation/deactivation were considered as the most basic ones, since all specific emotional experiences could vary on these two continua. It was also suggested that motivational and situational contents "colours" the further content of any specific emotional experience. These two dimensions seem, furthermore, to be found by most researchers in trying to reduce the emotional spectra (i.e. Schlosberg, 1954; Frijda, 1970; Russell & Mehrabian, 1977; Thayer, 1978).

2.5 Functional role of emotions

So far we have mostly discussed the description of emotion. It is, however, regarded as important also to mention something about what functional role emotions may play for the organism. A statement very often found in the literature on emotions concerns the disorganizing effects of emotions. See for example Young (1961). Still more often such statements are found in the literature on stress and performance, as we shall see in the next chapter. Such views have, among others, particularly been critisized by Leeper (Leeper, 1948; 1970). He argued that the degree of disorganization must depend on whether functional changes in the organism are random or chaotic. And that is usually not the case in emotional states (except for very extreme ones), according to him. During fear, for example, a person is in an overall state of organisation, probably ready for flight. Therefore, Leeper viewed emotional processes as organizing actions and viewed emotional processes as motives which both gives rise to activity itself and also it's direction and persistence. Thus, he regarded emotions as motivational and ... "motives of all kinds are main factors in producing the goal-directedness of behaviour and mental activity". (Leeper 1970, p. 153.) He also critisized the traditional portraying of emotions as intense "outbursts", which are, according to him, relatively rare events. Emotions mostly do their work at moderate or weak intensities. Leeper regarded the fundamental property of emotions, to be their role in arousing and sustaining activity, in producing exploratory reactions, in facilitating learning, in facilitating choices between alternatives, or in initiating flight or attack reactions under malevolent circumstances. Intuitively, the idea that emotions are motivational and goaldirecting on a general level, seems to be sound since the organism in fact is striving towards what is experienced as pleasant and away from what is unpleasant. However, under some circumstances, especially in the short run, it is necessary to act in unpleasant conditions, in order to obtain what is regarded as most pleasant in the long run. During such conditions emotions may interfere with effecient functioning, especially intense emotions. How such interference comes about is the topic of next chapter.

Furthermore, Leeper also regarded emotions as "... perceptions of situations and that, commonly, they are long-sustained perceptions of the more enduring and significant aspects of such situations". (Leeper, 1970 p. 156.) (This view resembles those proposed by Schacter, Singer, Arnold and Lazarus.) From this he drew the implication that if emotions are perceptions of life situations, it follows to some extent that the achievement of a satisfactory emotional life for modern man will have to come through the creation of some appropriate objective reality, because our perceptual processes, although subject to some distortions, are a means for recognizing objective realities. To a certain degree, therefore, emotions cannot be changed without changing the external realities. This fact is very important to bear in mind when discussing feelings of depression, fear, insecurity, alienation etc. in society in general or in various specific situations, as well as when one is talking about different treatments of emotional disorders.

Another researcher who has emphasized the motivational aspects of emotions is Tomkins (Tomkins, 1970). He proposed that "The human being is thus urged by nature and by nurture to explore and to control the circumstances which evoke his positive and negative affective responses". (Tomkins, 1970, p. 110.)

Simon's views on the "motivational and emotional controls of cognition" (Simon, 1967, p. 29) are furthermore relevant in this context. He suggested that emotions have their value primarily as an interruption mechanism working on ongoing cognitive activities, thereby allowing the "central processor" to respond to urgent needs in real time.

2.6 Anxiety and depression

Finally, let us discuss some points regarding anxiety and depression, the two emotional states which are mostly studied under the heading of emotional disorders. To take anxiety first, there seems to be an overwhelming diversification of theory and research (as in the whole area of emotions). However, one rather fair conclusion that can be drawn, is that there seem to be two sorts of anxiety, namely trait anxiety and state anxiety (Spielberger, 1966; Strongman, 1973). The former is a more enduring personality characteristic while the latter is more transient and situation bound. The extremes of both these are possible to describe as pathological, or as having pathological effects. According to Strongman (1973) this conclusion is somewhat similar to Freud's ideas of neurotic and objective anxiety and has also a parallell in endogenous and reactive depression. Spielberger (1966) suggested that anxiety as a state is characterized by subjective conscious feelings of apprehension and tension, including ANS arousal. Anxiety as a personality trait, on the other hand, is more like a motive or an aquired behavioral disposition, predisposing the perception of a threatening environment and also predisposing the responses to those threatening situations.

According to Malmo (1959), it has consistently been found that chronically anxious people show much more reactivity than normals. It is also a common finding that anxious people are more susceptible to stress (see for example Sarason, 1961). Eysenck (1969) furthermore reported that anxious people are easier to condition than non-anxious. Thus it seems that the anxious human has a heigthened sensibility of the perceived malevolence in life, i.e. "there is a wolf behind every tree".

Commonly, it is regarded that chronic anxiety is closely related to psychosomatic disorders, such as asthma, peptic ulces and hypertension. One very common explanation for this relationship is that, biologically, emotions energize survival functions. Nowadays, however, violent physical responses are met with social disapproval. Hence, we experience emotion from physiological change, but have no opportunity to discharge out energy behaviorally. Organic changes persist and pathology results (Bronner & Levi, 1970).

In discussing the causes of anxiety, the role of disturbed interpersonal relationships has been emphasized. Bowlby (1969) argued for the role of affectional bonds, particularly those between mother and child, in the formation of pathological anxiety, and Freud considered anxiety as the reaction to the possibility of the loss of a loved object.

The research on experimental neurosis has also put some light on the causes of anxiety (see for example Smart, 1965). It has been shown that conflict between approach and avoidance tendencies generally leads to an extremely fearful state of neurosis in animals, i.e. subjects do not dare to approach a pleasant stimulus because they are uncertain whether it at the same time is an unpleasant stimulus.

As with anxiety, the literature on depression is large and complex. There is no theory that is widely accepted, perhaps with the exception of Seligman's model of depression as learned helplessness (Seligman, 1975), which is often cited. He proposed that anxiety is the initial response to stress, but if there is no way to control the situation or decrease stress, anxiety is replaced by depression. He stated that "... the cause of depression is the belief that action is futile. What kinds of events set off reactive depressions? Failure at work and school, death of a loved one, rejection or separation from friends and loved ones, physical disease, financial difficulty, being faced with insoluble problems and growing old. There are many other reasons but this last captures the flavour. I believe that what links these experiences and lies at the heart of depression is unitary: the depressed patient believes or has learned that he cannot control those elements of his life that relieve suffering, bring gratification or provide nature - in short, he believes that he is helpless" (Seligman, 1975, p. 93). In Strongman (1973) research by Gellhorn and Loutbourrow (1963) is referred to, which may give credence to Seligman's proposals. They suggested that in combat, fear and anxiety is the first reaction. Those who are exposed to such fear for longer periods of time and are unable to conquer it, however, usually become emotionally exhausted, dull, listless, apathetic and depressed. Thus, the sequence which Seligman proposed.

2.7 Conclusion

To summarize this brief chapter on the psychology of emotions, it can be stated that emotions include an interaction of physiological arousal and cognitive interpretations of internal cues and external cues. There is a wide diversity of different emotional experiences, but they seem to vary at least in two general dimensions: pleasantness/unpleasantness and activation/deactivation. The goal directing and interrupting functions of emotions are emphasized. Emotional disorders, involving anxiety and depression, may be partly understood within the framework offered by the psychological analysis of emotions - and so may their relation to psychosomatic disturbances.

3. The influence of emotions on information processing

3.1 Introduction

Rather surprisingly, little research is done in combining the "cold" subject of information processing with the "hot" field of human functioning, emotions and motivations. This lack may partly be due to the fact that the modern study of information processing is relatively new, partly to the difficulties in creating or finding suitable and realistic situations where it is possible to objectively study the interactions of the two areas mentioned above and partly due to conceptual difficulties in accounting for emotional influence on cognition. The wide individual differences in the reactions to emotional situations create still further difficulties.
However, a related field of inquiry is that of stress and performance. This area has, on the other hand, produced an enormeous mass of articles, particularly during the fifties and sixties. Therefore, any attempt to review the findings on emotional influence on information processing would be incomplete if not including research dealing with this relatively well-documented area.

3.2 Stress

The concept of stress was first introduced by the endocrinologist Selye (Selye, 1950). He defined stress as a general adaptation syndrome, which acts to restore physiological homeostasis in an organism exposed to various harmful or stressing agents. Any condition that produces this syndrome may be called a stressor, whether it is physical injury or anticipation of some psychological threat. Thus, Selye viewed stress as a physiological response. The concept was soon adopted by psychologists who used it to denote a wide diversification of conditions.

Some of the more important psychological notions in this field are as follows. Lazarus, Deese and Osler (1952) suggested that stress occurs when a particular situation threatens the attainment of some goal. Simalarly, Cofer and Appley (1964) defined stress as the state of an organism perceiving its well-being to be endangered and McGrath (1970) emphasized that stress is the result of an imbalance between demand and the organism's capacity. Beier (1951) defined stress as the perception of threat, with resulting anxiety. And finally, Bergström (1970) regarded stress as a generic term for the processes, physiological and psychological, which are caused by physical harm or anticipation of harm to the individual.

It is possible to find many more specific definitions of stress, but whether it is considered as a response, or an imbalance between demand and capacity, or a percept, it is commonly accepted that stress includes emotional properties: "Thus, emotion is aroused together with the organic changes that are implied when we speak of the stress syndrome,..." (Arnold, 1967, p. 124). The fact that stress and emotions are connected makes it necessary to include stress research in a review on emotions and information processing, regardless of the wide diversification on the definitions of stress. The most common emotional experiences under these circumstances are obviously negatively toned ones, like grief, fear, and anger.

3.3 Stress and performance

Stress and performance are usually studied in the field or in experiments. As examples of the former one might refer to Andersson (1976), who examined the relationships between stress, coping behaviors, and performance among owner-managers whose enterprises were damaged by a flood hurricane. Grinker and Spiegel (1945) studied stress reactions among flying personell during World War II. Walker and Burkhardt (1965), cited by Baddeley (1972), related performance to degree of combat stress for different aircraft weapons involving various types of control. Fritz and Marks (1954) investigated human reactions to various kinds of disasters.

Observational data are, of course, as usually, difficult to interpret because of the many interfering factors and the difficulty to obtain them. This fact has led several investigates to carry out more controlled experiments. The techniques used to induce stress in experimental situations are mainly of three classes:

(1) Failure-induced stress (i.e. unsolvable tasks or false norms).

(2) Task overload.

(3) Stress induced by threats (e.g. electric shocks or cold showers).

Examples of failure-induced stress and anxiety on performance are given by Katchmar, Ross, and Andrews (1958), who studied a complex verbal coding task. As an example of threat-induced stress Patrick (1934) threatened subjects with cold showers and observed the subjects' attempts to find their way out of the room. And as an example of task-overload, Cumming and Croft (1974) examined performance of forced paced serial reaction tasks under stress induced by task overload.

A main difficulty in the experimental study, of stress is, the degree of realism that can be produced. The ethical problems are also great obstacles in experimentally simulating real life threatening or dangerous situations, like those experiments performed by Berkun, Bialek, Kern, and Yagi (1962), who among other things led recruits believe that they had injured their comrades and then studied their performance level. Another difficulty is that people rarely perceive stress manipulated in experimental settings in the same manner or are equally motivated to perform.

A further experimental approach is to take advantage of the fact that people do voluntarily subject themselves to real danger in such activities as parachute jumping and deep sea diving. These circumstances have for example been capitalized by Fenz (1964), who studied parachute jumpers and Baddeley (1972), who studied deep sea divers. Furthermore, it may be suitable to mention here that some reseachers have used emotionality inducing films as stress stimuli, as for example Lazarus, Opton, Nomikos, and Rankin (1965), and LeGarde, Lubman, and Hartnett (1971).

Stress usually - but not alway - brings about degraded performance. We first review some studies were impairment of various kinds of performance was found due to stress. Patrick (1934) showed that subjects demonstrated more stereotyped responses and less efficient performance in opening doors when they were stressed by cold showers or a loud noise. Berkun et al. (1962) found substantial impairment of performance in simulation of real life emergency situations. Baddeley (1966) found that performing underwater gave a performance drop of 49 per cent. In studies of rigidity in problem solving Cowen (1952 a, b) found that increasing degrees of experimentally induced stress elicited increasing amounts of rigidity with water-jar tests. Beam (1955) found that for serial learning his subjects under stress made 50 per cent more errors and required 50 per cent more trials to reach a criterion of mastery as they did under neutral conditions. In visual discrimination Marquart (1948) concluded that frustration resulted in slow learning, increased rigidity, and non-adaptive behavior. Beier (1951) showed that induced anxiety reduced the flexibility of intellectual functioning. Ainsworth (1957) found that the incidence of rigidity was significantly greater in stress groups than in non-stress groups. Ross, Rupel, and Grant (1952) examined the effect of different stressors on the performance of the Wisconsin Card Sorting Test (WCST), and found that physical threat significantly degraded performance on this test. D'Amato and Gumenik (1960) found a marked impairment of subjects' recall of stimulus events and their behavior during shock trials. Osler (1954) found that complex arithmetic problem solving was depressed after failure induced stress. McClelland and Apicella (1947) used card sorting as a performance task and found that induced stress resulted in more trials needed before the criterion was reached.

Lantz (1945) obtained a statistically significant impairment of Stanford-Binet scores following a failure experience, but not after an experience of success. According to Renner and Renner (1972) performance on a moderately difficult concept formation problem was impaired during high stress for individuals and groups. Drwal (1973) showed that stress induced by a threatening examination impaired creative thinking. The number of ideas, the number of response categories, and the percentage of original responses were all reduced. Heimstra (1970) reported that a stress group showed significantly more errors than a control group in a simulated driving situation, particularly during the end of a test session. Drinkwater, Flint, and Clelland (1968) studied aviation pilots who flew simulated instrument flights under stress and non-stress conditions. They found that levels of somatic activity rose significantly from the control to stress flight, and that performance errors were fewer in those subjects with lower levels of somatic activity. Barker, Dembo, and Levin (1941) demonstrated a lowering of constructiveness of children's play following frustration. Carlzon and Lazarus (1953) reported that stress impaired digit symbol performance. In a study by Davidson, Andrews, and Ross (1956) failure stress and task-induced stress were found to impair time-pressured color naming. Feather (1966) found that failure induced stress impaired performance on anagram tasks. Ray (1965) showed that even relatively mild stress may impair problem solving performance. After an experience of failure a decrement in recall and relearning of nonsense syllables was reported by Zeller (1950). Verville (1946) found that experimentally stressed subjects were distinctly slower in completing and recognizing incompleted pictures. Postman and Bruner (1948) found that subjects under stress had a higher treshold for the correct perception of three word sentences, and were more reckless in their prerecognition hypothesis. And, finally, Bergström (1970) concluded from a series of studies that increasing stress leads to impairment of tracking performance.

However, despite this array of studies showing impairment of different performance measures, performance decrease has not always been found to follow from stress. Facilitation of performance by failure stress has been reported for simple addition problems (Steisel & Cohen, 1951), and a visual counting task (Vogel, Raymond, and Lazarus, 1959). Chiles (1958) found in a learning experiment that a stress group was significantly superior on associated items and, after being initially inferior, consistently superior on non-associated items. Murphy (1959) reported that there were significantly fewer errors in a threat condition in a study on visual discriminations. Lipsett and Lolardo (1963) found that time pressure stress reduced errors of children's performance on a simple "oddity" task (i.e. they had to choose one of three primary colors that did not belong in a grouping, when two of the colors were obviously related). McKinney, Strother, Hines, and Allee (1951) reported two kinds of reactions to stress. While most subjects speeded up performance at the expense of accuracy and were more variable, others showed a more stable performance without any increase of speed or errors. And in a study of a highway safety "scare" film and its effect on performance LeGarde et al. (1971) found that all subjects had an increase in perceptual motor test scores after viewing the film.

Thus, summarizing the research reviewed above it is observable that the picture of stress and performance is rather complicated. Most authors report a decrement of performance as a function of stress but others report improvements. As explanations of these contradictory results one might propose the striking individual differences reported by Lazarus et al. (1952) in response to stress (some of these findings are discussed in a following chapter). But more commonly the different results have been interpreted as due to the intensity of the stress manipulations. According to Lindsley (1970), Malmo (1959), and Duffy (1962) the intensity of stress is reflected in the arousal level of the organism and the relationship between performance and arousal level has commonly been described according to the inverted-U hypothesis (Yerkes and Dodson, 1908; Hebb, 1969). This model simply states that as stress increases and the resulting arousal rises, so performance improves until some optimum point is reached but thereafter declines. There are several studies supporting this curvilinear relationship, based primarily on motivationally induced arousal, but also stress induced. For example Renner et al. (1972) showed that performance on a concept formation problem task was related in a curvilinear manner to stress for individuals but not for groups (this may be due to the fact that groups seem to be less susceptible to stress than individuals; see Bem, Wallach, and Kogan, 1965). Andersson (1976) found that perceived stress and performance displayed an inverted-U relationship. Sanders and Baron (1975) found that heightened arousal induced by distractions tended to facilitate the performance on simple tasks, while it impaired performance on more complex tasks. Simonov, Frolov, Evtushenko, and Sviridov (1977) found in a study of recognition of visual patterns that a moderate degree of emotional stress improved performance efficiency.

In discussing performance and the inverted-U curve it may furthermore be of value to present, as a parenthesis, the findings of Cumming and Croft (1973), who studied performance of forced-paced serial reaction tasks during continously varying demands. They found as expected from the inverted-U hypothesis that performance rose to an optimum peak, as a function of demand, beyond which it deteriorated. However, the peak achieved under increasing demand was not reached again under decreasing demand. Instead, performance remained approximately constant until a considerable reduction in demand had occurred. The phenomenon, which the authors called a "hysteresis" effect is shown schematically in Figure 3.1.

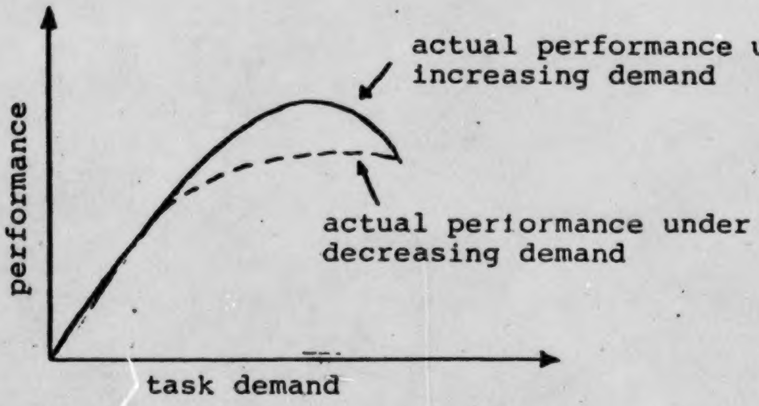

Figure 3.1. The hysteresis phenomenon in human information processing. (From Cumming and Croft, 1973, p. 16.)

This finding may have wide inplications for such activities as driving or flying where task demands (and also emotional arousal) continuously are shifting, because performance may be impaired even after demand overloads or emotional arousal have seized.

It seems also to be true that the intensity or stress affects different performance tasks differently. It is generally agreed that difficult, complex or poorly learned tasks are more susceptible to stress than easier or well-learned ones (Bergström, 1970). Thus, the more demanding the tasks are on the information processing capacity, the greater is the influence of emotionality inducing stress. That this probably is the case was nicely showed by Murphy (1959) who examined the effects of different visual displays on discriminations. He found that the differences between the easiest and most difficult display was significantly smaller during non-threat conditions than during threat conditions. He also referred to other studies which showed that the effect of a given increment of stress is greater if it is added to a higher rather than a lower existing level of stress (see Chapanis, 1954; Conrad, 1950; Mackworth, 1952).

Broverman, Klaiber, Vogel, and Kobayashi (1974) presented furthermore some very interesting ideas treating the relationships between various types of tasks and stress. In reviewing a large number of articles, dealing with experimentally induced short-term versus long-term stress on various kinds of mental performance (several of these are reviewed above), they argued that optimal short-term exposures to stress facilitates performance of serial, repetitive, overlearned tasks, according to the inverted-U curve, and impair performance of perceptual restructuring tasks, according to a U curve. However, long-term exposures to stress produces the opposite effects on performance (see Figure 3.2).

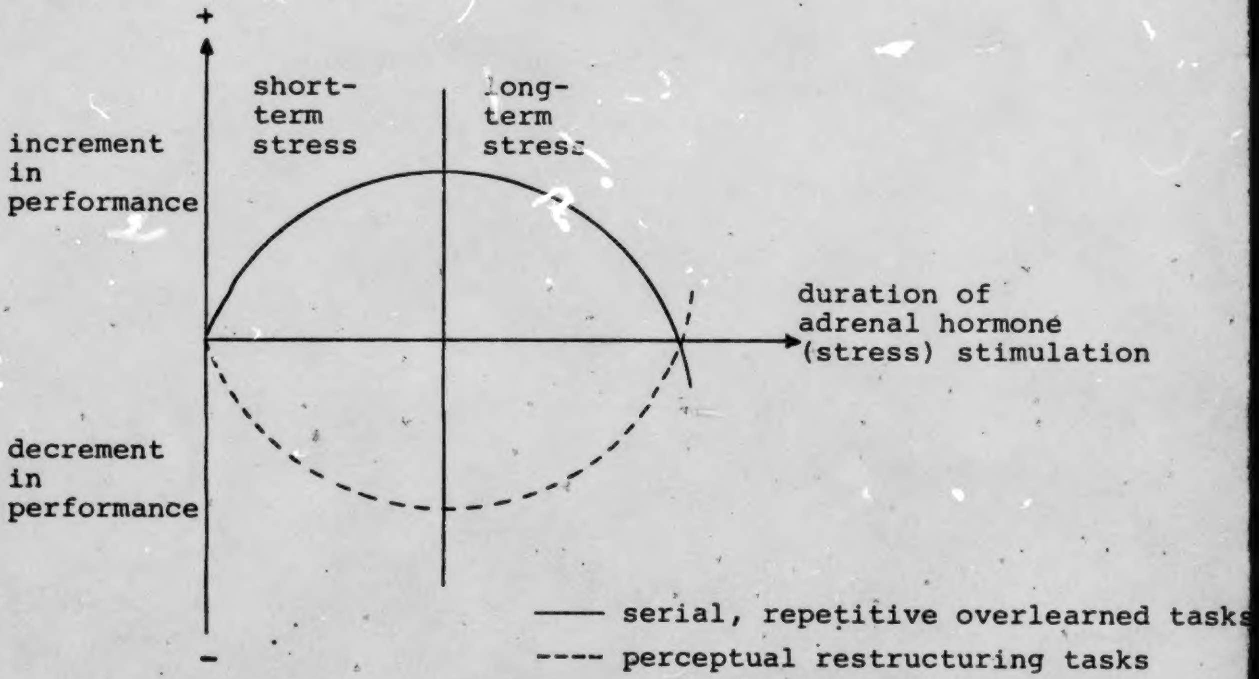

Figure 3.2. Hypothetical performance curves of serial, repetitive overlearned and perceptual restructuring tasks as a function of duration of adrenal (stress) stimulation. (From Broverman et al. 1974, p. 677.)

They suggested that both serial repetition and overlearning permit the maintenance of a single psychological set, or focus of attention, during task performance, while perceptual restructuring tasks are novel tasks that require the individual to set aside or inhibit immediate responses to obvious stimulus characteristics in favor of responses to nonobvious stimulus attributes. Such tasks are suggested to be heavily represented in standard intelligence tests, which are commonly used in the research on stress and performance. According to the authors these effects are attributed, in part, to the length of exposure of the central nervous system to stress-elicited adrenal hormones (adrenaline, cortisol). Short-term stress exposures are believed to induce states of central adrenergic dominance that favor performance of serially repetitive, over-learned tasks at the expense of perceptual restructuring tasks. Longer exposures of stress, on the other hand, are thought to result in a shift to central cholinergic dominance that favors the opposite pattern of performance. Further credence to the last suggestions are given in Broverman, Klaiber, Kobayashi, and Vogel (1968), where it is proposed that performance of serially, repetitive, over-learned tasks is improved by adrenergic stimulants such as amphetamine or caffeine, and depressed by adrenergic blocking agents such as chlorpromazine. On the other hand, perceptual restructuring tasks are thought to be cholinergic dependent since performance of these tasks is enhanced by cholinergic stimulants and impaired by cholinergic blocking agents.

In connection with the views proposed by Broverman et al. it may be suitable to refer to Crawford (1961) who suggested that stress factors inherent in the driving situations may lead to a condition which he described as "stress fatigue". This type of fatigue, which is characterized by an increased rate of emotional arousal, involves two phases. During the first phase emotional arousal leads to oversensitive behavior with a driver showing unexpectedly strong responses to very slight irritations (perhaps corresponding to Broverman's short-term stress with adrenergic dominance). If emotional arousal is continued, there is a second phase which is characterized by a reduction in intensity of response to the environment and a raised threshold of arousal (which may be similar to Broverman's views on the effects of long-term stress with cholinergic dominance). Poulton's (1970) suggestions that optimum arousal level for performance tasks were accuracy is emphasized are lower than those where speed is stressed is also consistent with Broverman.

Thus, tasks that require the individual to set aside or inhibit immediate responses to obvious stimulus characteristics in favour of responses to non-obvious stimulus attributes are more susceptible to stress. This is rather well illustrated by some further studies. Palermo (1957) investigated the effects of stress on performance in a learning task where the stimuli had to be paired with responses varying in initial habit strength. His results were in agreement with the proposal above in that the stressed subjects made more errors than the non-stressed subjects on the associations with low habit strength and fewer errors on the assosciations where habit strength were relatively higher. Similar results were also obtained by Castaneda and Palermo (1955). Usdansky and Chapman (1960) examined the effects on association errors of time pressure stress and found that errors based on contiguity of objects in common experience, e.g. hat-head, dragon-wagon, etc., were more common in the stress condition than in the non-stress condition where the associative errors were more equally distributed on the different classes.

Related to the findings above are the results of Barthol and Ku (1958), who showed that if a person has learned two alternative responses to a stimulus configuration and is placed under stress, unrelated to the behavior being observed, he responds to the stimulus with the earlier learned behavior pattern. They called this phenomena "regression under stress to first learned behavior". These facts may be very important to bear in mind when training and re-training operators in man-machine systems that are to function effectively even under stress conditions.

Thus, the curvilinear relationships between arousal and performance levels seem to be rather accurate on a descriptive level. However, few suggestions have been proposed to explain these curvilinear relationships, or where the optimum points occur, except for Broverman et al. (1974). In attempts to put further lights on this, Welford (1974) combined the inverted U hypothesis with the signal detection theory. According to this latter theory the brain is conceived as being spontaneously active in such a manner that incoming signals have to be distinguished from a background of random neural firing, known as neural noise. In its simplest form, signal detection theory holds that the intensity of the noise varies from moment to moment, so that if its instantaneous intensity is plotted for a large number of occasions, they will fall into a distribution as shown to the left in Figure 3.3. The signal adds a constant to this noise and thus forms a second distribution as shown to the right in Figure 3.3. The subject establishes a cutoff point and treats everything below it as a noise alone or "no signal". The lower the cutoff, that is the further it is to the left, the more signals will be correctly detected and the fewer will be missed, but at the same time the fewer cases of "no signal" will be correctly identified and the more falsely regarded as cases in which a signal is present, so called "false positives" or "false alarms".

Welford assumed that as arousal increases, the cells of the brain become readier to fire and if so, both noise and signal should increase with arousal level in such a way as to leave the ratio between the standard deviation of the distributions and the distance between their means roughly unchanged as shown in Figure 3.3 A-B.

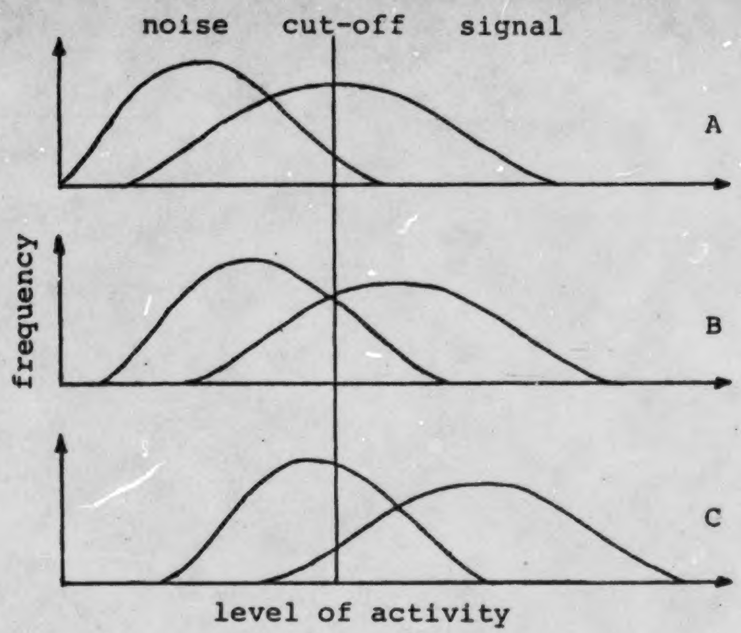

Figure 3.3. Distributions of noise and signal for three levels of arousal; low (A), optimal (B), and high (C). (From Welford, 1973, p. 572.)

Welford further suggested that the signal detection theory in this form accounts well for the inverted-U relationship between arousal and performance. He assumed that the frequencies of signal and no-signal are equal. If arousal is so severe that virtually the whole of both distributions are to the left of the cutoff, an exaggerated form of Figure 3.3A, all cases of no-signal will be reported correctly, but none of the cases of signal, so that theoretically 50 per cent of the subjects' answers will be correct. As the distributions move to the rightwith increasing arousal, more of the signals will be reported correctly and there will be a proportion of false-positives, but the former will outweigh the latter so that the total number of correct responses will rise until the condition shown in Figure 3.3B is reached. As the distributions moves still further to the right in the manner of Figure 3.3C, the proportions of signals correctly identified will continue to rise, but the "false positives" will rise still further. And in the extreme, when both distributions are wholly to the right of the cutoff, all signals will be reported corretly and all cases of "no signal" will be incorrectly responded to as "false positives", so that the total correct responses will again theoretically be 50 per cent.

In a more difficult task the two distributions are assumed to be closer together and in easier tasks they are more separated. Thus, as the differences become greater, the optimum occurs at a higher level of arousal and maximum performance rised for easier tasks.

Welford defined noise as a random neural firing, but one may perhaps also think of noise in these circumstances as interfering responses or thoughts that may be evoked in emotional situations, such as thoughts of worry and fear. Such self-focusing tendencies may be interfering with effective performance (Morris and Liebert 1970, and Wine, 1971).

However, perhaps the most important implication of Welford's approach is the distinction it draws between the impairments of performance by under- and over-arousal. Below optimum, the subject is underactive and errors are mainly those of omission. Above optimum he is overactive and errors are largely those of commision. That this may be the case was illustrated by the findings of Simonov, Frolov, Evtushenko, and Sviridov (1977), who studied the changes in efficiency of the recognition of visual patterns against a background of noise throughout an increase in emotional stress (as measured by a fixed sum of ECG parameters; i.e. average sum of R-R interval and amplitude of T-wave), caused by a forthcoming parachute jump. They found that an optimal degree of emotional stress improved performance efficiency on the task and decreased the number of the subjects' errors. However, they also found that the kind of errors changed with increased emotional stress according to the views proposed by Welford; i.e. an increase in the number of "false alarms" errors along with a decrease in the number of omissions to reaction signals (see Figure 3.4).

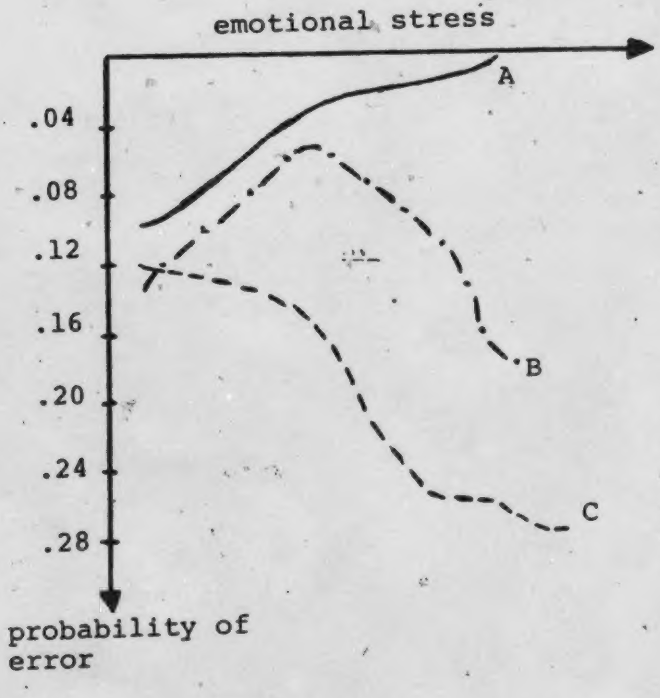

Figure 3.4. Probability of errors in relation to degree of emotional stress. A = omissions, B = total amount of errors, C = false alarms. (From Simonov, Frolov, Evtushenko, and Sviridov, 1977, p. 857.)

From this figure it can be seen that a stronger emotional stress was accompanied by a decrease in the number of omitted signals, when the subjects interpreted a figure as noise (A) and an increase in the number of false alarms when the subjects interpreted noise as a figure (C). The total number of errors on the other hand, first decreased and then started to increase (B).

A further possible explanation of the relationship between emotional arousal and information processing lies in the suggestion, made by a number of workers, that an increase in emotional arousal produces a narrowing of attention, with the subject concentrating more and more on the central features of the task and paying less and less attention to more peripheral ones. Such views have for example been proposed by Teichner (1968), and Callaway and Dembo (1958), but particularly by Easterbrook (1959). In reviewing a large body of research the latter suggested that emotional arousal consistently acts to reduce the range of cues that an organism uses.

The following are examples of the research Easterbrook primarily cited to support his generalizations. Firstly he referred to studies of the effects of experimentally manipulated drive level on response to a focal task, and a simultaneous response to peripheral, only occasionally relevant stimuli. Arousal reduces responsitivity to the peripheral stimuli while maintaining or improving central performance (Bahrick, Fitz, & Rankin, 1952; Bursill, 1958; Davis, 1948). Secondly, he referred to studies of the effects of emotional arousal on measures of incidental learning. Again arousal reduced the amount of incidental learning, while having no effect on or improving intentional learning (Brunner, Matter, & Papanek, 1955; Aborn, 1953; Bahrick, 1954; Johnson, 1952; Kohn, 1954; Silverman, 1954; Silverman & Blitz, 1956). And, thirdly, studies on visual perception under emotional arousal were investigated. In referring to such studies Easterbrook argued that one means of constructing perceptual tasks that will require the use of a large number of cues, is to reduce the amount of cues normally available in relatively easy tasks. This might be done, according to him, by reducing the physical differences between discriminanda, lowering illumination, reducing exposure time, physically cutting out some stimuli with reduction screens and so on. In such conditions relative impairment in discrimination has been reported to arise from pre-parachuting anxiety (Basowitz, Persky, Korchin, & Grinker, 1955), and from threat-induced and manifest anxiety (Moffit & Stagner, 1956). The reports of impaired night vision among neurotics (Eysenck, Granger, & Brenglemann, 1957) may also, in Easterbrook's view, signify a reduction in cue utilization due to high emotional arousal. Furthermore Eysenck et al. (1957) found that a factor, which measured speed and accuracy of recognition with impoverished displays showed considerable power for differentiating between normal's and neurotic's.* They also

*Note that these findings may illustrate some alternative explanation of the effects of percept-genesis (Kragh & Smith, 1970).

drew particular attention to the fact that the duration threshold for perception of the third dimension was among their most discrimative measures. A loss of distance cues due to arousal was also found by Callaway and Thompson (1953). When their subjects were required to hold one foot in a bucket of ice water, they consistently overestimated the size of a standard stimulus. They also found a breakdown in ability to estimate distance under similar conditions. Related to these suggestions are the findings of Westheimer (1952), who showed that emotional states influenced the accomodative level of the eyes in his subjects. Subjects who were made angry by insulting remarks directed to them showed a rise in accommodative level (they became more nearsighted), lasting for several minutes. Furthermore, according to Erdelyi (1974) who refered to several studies, there is evidence that the perceivers' pupils expand and contract in diameter partly as a function of the perceivers' attitudes and needs (e.g. Hess, 1965; Hess & Dolt, 1960; Hutt & Andersson, 1967a, 1967b). Such variations in pupil size may actually alter the perceivers' sensitivity to the stimulus (Hutt & Andersson, 1967a, 1967b). In referring to Fry (1936) he also proposed that differential accomodation of the lenses may be a selective mechanism, and he stated that, although the evidence is not uniformly supportive (e.g. Lack, 1971), such findings raise the possibility that accomodation might be utilized under some circumstances to effect inhibition of unwanted input into both eyes through voluntary blurring of the retinal image. Thus, these studies suggests that emotions may influence even more basal perceptual mechanisms. However, it seems to be difficult to interpret these findings into a more coherent understanding by what means they do so.

Since Easterbrook's review, several studies have reported similar effects of emotionality on the range of cue utilizatio in task performance. Weltman and Egström (1967) studied novice divers who were required to perform a central task while monitoring a faint peripheral light. While the central task did not affect peripheral vigilance on the surface, during diving a distinct subgroup of the subject's emerged, showing much slower responding to the peripheral light, while showing no impairment on the central task. Wachtel (1968) found that subjects threatened with shock performed no differently than an unthreatened control group on a tracking task occupying the center of their attention, but had significantly longer reaction times to lights which went on occasionally at the periphery of their visual field. In a similar study Bacon (1974) concluded that arousal narrows the range of cues processed by systematically reducing responsiveness to those aspects of the situation which initially attract a lesser degree of attentional focus. This stimulus loss under arousal represents, according to Bacon, independently of any response criterion changes, an actual diminution in the subjects' sensitivity. Furthermore, he suggested that arousal mediates its effect not so much by impending the initial sensory impression as by affecting the capacity limitations and attentional control processes operating within short-term memory. Hockey (1970) induced arousal by a loud noise and arrived at the same conclusions in a similar study. In a further study, Hockey (1973), in which the subjects were required to monitor three sources of signals indicating occasional faults in a machine system, he found that loud noise produced increased sampling of the source associated with a high fault probability, while sleep loss, presumed to decrease arousal level, resulted in a reduction of sampling on the high probability source. In addition, systematic changes were found in the detection of faults, once they were located on a particular source. Noise tended to remove the tendency to check sources twice before correcting the fault, while sleep increased the frequency of these uncertain responses. This means that noise increased the tendency to make definite decisions (hits or misses) about the need for a fault to be corrected, while sleep loss resulted in a higher proportion of doubtful decisions. These results may furthermore be interpreted in accordance with the suggestions made by Smock (1955a) and Postman and Bruner (1948) treating premature decision making and stress discussed below (p. 30 and 31).

One possible measure of the extent of the perceptual field is the "range of perceptual anticipation", which may be interesting to discuss here. This range is the amount of perceptual material in a serial array between the point reached by perception and that reached by action in a serial perceptual motor task. Reaching aloud is a common illustration in referring to such a range. When subjects who are reading aloud are interrupted they can usually report that they have percepiated more words than they have spoken. The number of these words may be defined as the receptor - effector span. According to Easterbrook, this "receptor-effector span" reflects the extent of utilization of task cues, and thus is susceptible to emotional stress. This should mean that performance on tasks that need a long "receptor-effector span" to function smoothly, like driving or low-altitude flying, should be specially impaired under emotional stress. However, Easterbrook did not cite any research pertaining to this suggestion, and as far as the present authors know, there have been no studies treating the effects of emotions on the "receptor-effector span" in simulated driving or flying situations.

However, on some tasks only a small amount of advance information is needed for the preparation of adequate responses, and additional foreknowledge may even be a handicap, thus serially, repetitive and over-learned tasks in the sense of Broverman et al. Consequently, performance of such tasks should be less susceptible to emotional stress. More complex functioning, which demands a large number of informational cues should, on the other hand, be impaired under emotional circumstances, for example tasks that require some degree of flexibility. This has been shown in the studies by Cowen (1952 a, b), Marquarst (1948), Beier (1951), and Ainsworth (1957) to take some examples.

One implication of the discussion above is, again, that the effect of emotion may be either facilitative or disruptive depending on the task in question. Tasks requiring the use of greater number of cues should be disrupted, while tasks requiring the use of smaller number of cues should be less disrupted or even facilitated by emotional stress increment.

According to Easterbrook, continued reduction in the range of cue use would first improve and then impair proficiency, thus producing the inverted-U relationship, discussed earlier. He assumed that simultaneous use of task-relevant and task-irrelevant cues reduces the effectiveness of response to some extent, and that as the total number of cues in use is reduced, task-irrelevant cues are excluded before task-relevant cues. When all irrelevant cues have been excluded (so that the task demands the total capacity of the subject), further reduction in the number of cues exemployed can only affect relevant cues, and proficiency will fall.

In this context it may furthermore be suitable to cite the proposals made by Wine (1971), who suggested that the adverse effects which test anxiety has on task performance may be due to the fact that, during task performance, the highly test anxious person divides his attention between self-relevant and task-relevant variables, in contrast to the low-test-anxious person who focuses his attention more fully on the task. By self-relevant variables she referred to thoughts of worry, self-blame or other self-ruminating tendencies, which are much more common among high-test-anxious than low-test-anxious. And according to Morris and Liebert (1970), the attentionally demanding cognitive activities like worry, are more debilitating of task performance than just arousal. Such interfering thoughts may also underlie the results obtained by Sjöberg and co-workers (Sjöberg & Johnsson, 1976; Sjöberg & Samsonowitz 1977; Sjöberg & Persson, 1977), who found that several kinds of distorted reasoning followed mood pressure.

Easterbrook also made some interesting suggestions on the effect of learning to function effectively despite emotional interference: In the first place, learning might be expected to reduce the number of irrelevant cues in use. A second effect of learning might be to increase the number of relevant cues in use, and consequently to raise proficiency further. And the third major effect of learning that might be expected is the one discussed by Miller (1956) as coding. Groups of cues may come to form larger peceptual units, attached to larger response units, so that the number of cues required for proficient performance might decrease.

3.4 Processing of emotionally provocative stimuli

So far the literature reviewed has particularly concerned the effects of stress or emotions on performance of extraenous tasks, that is tasks that not per se are emotional. However, it is also rather well-documented that emotional stimuli are processed differently than more neutral ones. The research on perceptual vigilance/ defense, mainly started by Bruner & Postman (1947) and McGuinnies (1949) has particularly shown this. In Erdelyi (1974), an extensive review is given on this research and of the major criticism that have been leveled against it. He considered the perceptual defense/vigilance effect as a special instance of selectivity in cognitive processing. He specifically argued that selectivity, and therefore perceptual defense and perceptual vigilance, is a multiprocess complex phenomenon under central regulative control. Selectivity, and consequently defensive selectivity, is brought into play through varied mechanisms at multiple loci of the information-processing sequence. Thus, selectivity is, according to him, pervasive throughout the cognitive continuum, from input to output, and no single site is likely to provide exhaustive explanations of any substantial selective phenomenon.

In the classic perceptual defense paradigm the proposed sensitivity decrements or increments occur in response to a tachistoscopic single-glance stimuli. However, it is suggested by Erdelyi that such sensitivity differences between isolated stimuli are ultimately superficial, especially in the case of complex visual displays such as those experienced in real-life situations. In consequence of this, Erdelyi and co-workers performed some experiments which examined the effects of emotional stimuli under more complex, real-life conditions (Suedfield, Erdelyi, & Concoran, 1975; Erdelyi & Appelbaum, 1973). In the study first mentioned he let subjects watch a film sequence that was abruptly terminated and followed by a letter matrix. One group saw a film of high emotionality, while a second group saw one of low emotionality. A control group was shown a blank, white slide followed by the same letter matrix as seen by the other subjects. When film subjects were divided into those who rated the films as highly disgusting and those who rated the film as little disgusting, it was shown that control subjects had the highest sensitivity of the letter matrix; subjects who rated the film as little disgusting an intermediate level, and subjects who rated the film as highly disgusting the lowest. In discussing these results the author's suggested that the affective content of the emotional films introduces additional informational burdens upon the subject, forcing him to share his limited attention span over a wider set of input channels, including the affective. The similarity of this proposal with the ones suggested by Wine (1971), referred to earlier, is obvious.

Still further evidence to such views is given in a series of studies performed by Horowitz and co-workers (Wilner & Horowitz, 1975; Becker, Horowitz, & Campbell, 1973; Horowitz, & Wilner, 1976). In these studies it was shown that increased intrusive and repetitive thoughts is a general response tendency after arousal of negative or positive affects as induced by films. And probably these intrusions and repetitions and interfering with the processing of simultaneous neutral information.

In Erdelyi and Appelbaum (1973) it was furthermore found that the detection of a briefly, simultaneously presented configuration of eight neutral stimuli was inferior when the ninth member of the stimulus dispaly was an emotional rather than a neutral item. The ninth stimulus comprised of either a Swastika, a star of David, or a schematic window presented in the center of the display. The subjects were members of Rutgers Hillel Foundation (a Jewish organization), a group for which the emotional symbols, whether the negative Swastika or the positive star of David, could be expected to have particular salience. The proportion of subjects correctly recalling their central item was 17/22 for the swastika group, 17/19 for the star of David group, and only 10/17 for the window group. However, out of the set of eight neutral orbit items, the three groups (Swastika, star of David, and window groups) correctly recalled an average of 1.27, 1.37, and 2.12 items respectively, and these differences were significant. Thus, the subjects recalled the emotional stimuli to a greater extent, while the recalling of the neutral stimuli was impaired when the centrally posited stimuli was an emotional one.

Results that can be interpreted as similar to those of Erdelyi and co-workers is presented in Schultz (1971). She found a significant detrimental effect on recognition of items immediately preceding and immediately following "high-priority events", which were names of famous people inserted in lists of common words. Some results by Fenz (1964), who studied parachutists awaiting their first jump are also in lieu to what is presented above. Firstly, he found that the auditory threshold for neutral words following words which were associated with anxiety and parachuting were much higher for parachutists on the day of jump than for control subjects. Secondly, he found that parachutists misperceived a high proportion of anxiety words, but significantly fewer parachute-relevant words, compared to the control group, but no differences were found on neutral words. However, neutral words following parachute-relevant words was much more misperceived by parachutists than by the control groups. The suggestion proposed by Horowitz and co-workers is also substantiated, while Fenz showed that parachutists on the day of jump produced an average of 12.8 parachute-relevant associations but two weeks from jump produced only 6.1 such responses. The following record of a parachutist's associations on the day of jump may further illustrate this: "Skydiver-jump; Hungry-jump; radiator-hot; happy-parachute; bicycle-jump, damn it, I can't get away from it!" (Fenz, 1964, p. 23).

In summarizing so far, there seems to be a scarcity of studies that corroborates the proposals made by Easterbrook that emotions cause a narrowing of attention and a reduction of cue utilization. However, several studies referred to above, point to the fact that emotional stimuli results in a focusing of attention on these stimuli. In considering this it might be more sound to speak of "direction" of the cue utilization instead of reduction. Perceptual defense phenomena may, however, miscredit such a statement. But logically, all kinds of systematically changed sensitivity are expressions of selectivity. Why this attentional selectivity under different conditions and with different individuals is expressed either in heightened sensitivity or in lowered sensitivity is discussed shortly in a following chapter. As further examples of these directional properties of emotional stimuli might once again refer to Leeper (1970), one argued that emotions are main factors in producing the goal-directedness of behavior and mental activity, and the wellknown study by Bruner and Goodman (1947), where it was found that poor children overestimated the size of a coin compared to rich children.

3.5 Emotions and decision making

There is also a scarcity of studies treating the effects of emotions on decision making. But some of the studies presented below may give some general suggestions on how such influences may be expressed. The results of these studies may also be interpreted in Easterbrook's terms. Thus, Dittes (1961) showed that ego-involving failure resulted in a pull towards more impulsive closure as represented by tendencies to find a positive meaning in an essentially incoherent prose passage rather than to acknowledge its incoherence, and to base an impression of another person exclusively on more prominent traits and to ignore inconsistent traits. He also suggested that persons experiencing a greater need to maintain or enhance their sense of self-esteem are more likely to impose closure.

Sjöberg (1976, 1978)also suggested that self-esteem is a crucial determinant in accounting for distortion of belief systems towards consistency. He reported (Sjöberg, 1978) that subjects with low self-esteem tended to have more consistency between beliefs and values.

In a study intended to test the hypothesis that psychological stress results in decreased tolerance of ambiguity, Smock (1955a) presented his subjects with a series of cards, beginning with an ambiguous card but with additional elements added in each succeeding card until the complete design or picture emerged on the final card of the series. In examining his results Smock concluded that stress made his subjects give definite responses to the stimulus configuration before adequate information was available for the correct response. He also found that the stress group was relatively retarded in their recognition of the completed stimulus and thus gave a later correct response than control subjects. These conclusions were also confirmed in Smock (1955b) but here he also showed that the performance of the stress group was further impaired when the ambiguous configurations were incongruent with familiar expectancies.

In an experiment concerning visual discrimination of complete versus incomplete figures presented tachistoscopically, Korchin and Basowitz (1954) concluded that emotional stress, caused by a forthcoming parachute jump, was reflected in poorer discriminations and a greater inability to resist the "pull of closure". In a study of the effects of stress on the recognition of three-word sentences, with the words successively presented, Postman and Bruner (1948) concluded that, under normal conditions, the final recognition is usually preceded by a period of systematic exploration, and the first three-word hypothesis is, more often than not, fairly close to fact. Under stress, much of the systematic exploration is short-circuited, and responses are triggered off as soon as the subject has a minimum of perceptual material to work with. Once having formed a perception on the basis of a premature hypothesis, the subject must "un-perceive" in order to obtain a correct perception. This achievement was more difficult to obtain under stress. Furthermore, Moffit and Stagner (1956) concluded from an experiment concerning ego-threat and perception that threat-induced anxiety modified the perceptual process by enhancing constancy. Previously established percepts (the original form of a closure series), the original picture in a series of changing figures, and the rectangular form, established by past experience, concerning Ames room, were adhered to mere tenaciously under threatening instructions. In interpreting these results, Moffit and Stagner suggested that the subjects scanned relatively more from interoceptive emotional cues and less from exteroceptive stimulus sources under threatening conditions. As supporting the view that anxiety may increase perceptual constancy one might also refer to Staw (1976) who examined the process of escalating commitment through a simulation of a business investment decision. His results showed that persons committed the greatest amount of resources to a previously chosen action when they were personally responsible for negative consequences. The emotional consequences of making these had descisions may be one responsible factor in causing this "rigidity" in line with the findings of Moffit and Stagner.

Probably related to the phenomena of "intolerance of ambiguity" are the findings of Brim and Hoff (1958), who found significant differences between frustrated, satisfied, and control groups in desire for certainty. The measures of desire for certainty consisted of statements as: "The chances that an American citizen will believe in God are about ... in 100" (Brim & Hoff, 1958, p. 225). The subjects had to fill in some probability value for each such statement. In addition the subjects had to indicate how sure they were of their estimates. Extreme ratings were taken as an indication of intolerance for ambiguity.

Though most of the studies last mentioned above seem to be rather far from the classical research on decision making, the findings, stated in general terms, may bear some relevance concerning emotions and decision making. Firstly, it is shown that emotional stress may cause a tendency to premature decisions. Secondly, decisions may to an increasing extent be based on familiar experiences or on the more outstanding cues. This means that the proposals made by Sjöberg (1977), that one might make decisions earlier in the chain of successively more demanding and complicated decision strategies, proposed by Montgomery and Svenson (1976) as due to stress, seems to be reasonable. It is also true that more demanding decision tasks include a larger amount of cues for optimum performance on the decision task in question. Easterbrook suggested that emotions reduce the number of cues utilized in a task but one might speculate on which cues are left or exaggerated in stressful conditions in real life situations. The results of Wright (1974) may cast some light on this question. In his study six groups of subjects were presented five pieces of information to assimilate in evaluating cars as purchase options. Three groups operated under varying time pressure conditions, while three groups operated under varying levels of distraction. He found that under high time pressure stress and moderate distraction the subjects disproportionately used more negative evidence in making their decisions. Subjects also attended to fewer data dimensions in these conditions.

Let us finally make some comments on emotionality and risk taking. From every day life it is obvious that affects play a role in spontaneous behavior that involves risks. It was for example shown in a study by McArthur and Haakonsen (1977) that spontaneity and deviation from prearranged plans was a common cause of military air display accidents. But also, this area of emotional influence is rather scarce with more controlled studies. However, in an explorative study concerning risk taking and test performance Lieblich (1968) found that stress conditions reduced the tendency to make risky answers. But in a more controlled experiment, with choices between different bets with different probability to occur (Lieblich, 1968), it was found that the amount of risk taking tended to increase in stress situations.

In a study by Brody (1963) the effects of n Ach and test anxiety on risk taking behavior and subjective probability of success in a sequential decision task was examined. It was found that subjects who scored high on n Ach and low on test anxiety tended to make their decisions in the intermediate quartiles of the distribution of reported confidence at the trial of decision more often than subjects who scored high in test anxiety and low in n Ach. This means that the low n Ach and high test anxiety subjects tended to decide in the first and fourth quartiles of the distributions i.e. to take unusually large or small risks. It was also found that the test anxiety variable was the major contributor to the significant differences between the groups. Hancock and Teevan (1964) found that subjects above the median on "fear of failure" choose the most difficult odds on the initial trial while subjects below the median choose the easier odds in a risk taking situation. The "fear of failure" subjects made significantly more irrational moves in odds after success or failure than did the "hope of success" subjects.

Thus, the results of these few studies are rather contradictory and hardly possible to interpret so far. One should also bear in mind that in the two last studies, the authors were more interested in anxiety as a personality variable. One part of the problem may also be the confused nature of the concept of risk taking as a special kind of decision making.

3.6 Conclusion

In summing up the most important influences of emotions on information processing it is suggested that the relationship between task performance and emotional arousal is generally curvilinear according to the inverted-U hypothesis. Tasks that are complex, include perceptual restructuring, or need a surplus of cues for effective performance, are more susceptible to emotional stress than over-learned, serially repetitive ones. These differences between tasks may due to influences of adrenal hormones and/or the fact that emotional stress reduces the number of task cues utilized in a performance situation. It is also suggested that emotional stress creates a tendency to impulsive closure and intolerance of ambiguity in decision making. Finally, it is shown that emotional stimuli have influences on the processing of information inherent in the emotional stimuli themselves, both spatially and temporally.

The main conclusion can be stated as a decrease in the flexibili of information processing mechanisms in emotionally excited states, concommittant with increased attentional selectivity of the emotional stimuli in question. In discussing the adaptive value of such a tendency one might propose that at times of emotional stress the organism does not have time to consider what it is going to do, but instead must act immediately. Or stated in terms of Barthol and Ku (1959, p. 136): "Thus, even stereotyped or regressive behavior allowed Aesop's cat to escape the hunters, since it was not necessary for him to take the time to select one of several responses. The fox, with many available responses, was caught and killed while making up his anthropomorphic mind".

4. Strategies for coping with threat

4.1 Introduction

All humans are from time to time exposed to more or less intense affect-inducing threats, i.e. accidents, failures, social problems, etc. However, usually we can handle these threats without getting disorganized or abnormally passive. This fact has led several psychologists into the studying of coping processes.

4.2 Cognitive coping/defensive mechanisms

One of the main contributers in this area is R.S. Lazarus, who proposed that there are basically two kinds of processes, by which individuals may cope with threat or anticipated harm (Lazarus, 1966). The first consists of direct actions such as attack and avoidance, which are designed to alter the organism-environmental relationships in such a way as to reduce or eliminate the threat. These direct actions may, however, be inhibited due to internal or external constraints. The second type of coping process by which emotional reactions can be reduced is entirely cognitive, in that it involves no direct action, merely further evaluations or reappraisals. This second type of coping processes is, according to Lazarus, the predominant mode of coping when direct actions are impossible. These cognitive reappraisals may proceed from a benign appraisal to a threatening reappraisal, or from an initially threatening appraisal to a benign reappraisal. Appraisal and reappraisal may be based on objective, new stimulus evidence, and hence involve good "reality testing", or may represent "defensive" distortions of reality. A listing of such "reappraisals" or cognitive coping mechanisms found in the research of stress and coping is given in Houston (1977). These are presented in Table 4.1.

Table 4.1. Categories of cognitive strategies for coping or not coping with stress (Houston, 1977, p. 208).

Category	Description of cognitive activity
Intellectualization	Taking objective, analytical and/or intellectual attitude toward threat
Isolation	Taking a detached attitude toward the threat
Denial	Not regarding the situation as stressful
Rationalization	Providing plausible reasons why situation should not be upsetting
Reversal of affect	Reacting with positive affect toward the situation
Supplementary projection	Projecting apprehension onto others
Complementary projection	Projecting malevolence onto others
Active mastery	Trying hard to do well on the task
Resignation	Patiently enduring the situation
Avoidant thinking	Thinking about things not relevant to the stressful aspects of the situation
Search of strategy	Alternating between or intermittently using coping strategies
Worry	Ruminating about various aspects of the stressful experience
Lack of strategy	Not attempting to employ a cognitive strategy nor observing about the situation

4.3. The use of coping/defensive strategies

Thus, so far it is proposed that different cognitive mechanisms may be put into play when people handle threats. Under more normal conditions or in the short run they may be beneficial in keeping the threat at some distance, but they may also cause fixations and reality distortion.

This maladaptive function of ego-defenses (or in Lazarus' term "coping strategies") have particularly been emphasized by the psychoanalytical school. But according to Chodoff, Friedman, & Hamburg (1964) this "abnormal" view of coping mechanisms probably derives from the fact that most psychiatric theories are based on the study of abnormal persons who have failed to deal adequately with the ordinary stress of living, which in turn may have introduced a bias in favour of considering defense mechanisms as pathogenic in themselves. Defense mechanisms are used extensively also by people who are not mentally maladjusted according to convertional social criteria. This, in turn, does not mean that defense mechanisms are altogether adaptive. "Pathogenic" use of them may characteriz various more or less abnormal personalities or extreme threats. This has for example been shown in the research on perceptgenesis by Kragh, Smith, and co-workers (Kragh & Smith, 1970). Where to locate the border line between adaptive and pathogenic use of defense mechanisms is however, difficult to say. Perhaps it is reasonable to propose that defenses used in connection with symbolic or imagined threats are non-adaptive, while they may be more adaptive when used together with real-life and realistic threat situations, at least in the short run.

That various strategies of coping may be effective in reducing the emotional impact of threats seems, however, to be a common finding in the reserach on coping and stress. To review some of these findings: Chodoff et al. (1964) found that parents of children with a malignant disease (leukemia), in most cases successfully, tried to keep the distressing event on a manageable distance by means of various defenses, where the most important were isolation of affect, denial and different kinds of attention demanding activities. In a series of studies by Sjöberg and co-workers concerning volitional problems (Sjöberg & Johnson, 1978; Sjöberg & Samsonowitz, 1978; Sjöberg & Persson, 1977), it was found that success in adhering to a long term commitment (i.e. stop smoking and decrease weight), in spite of mood pressure, was correlated with the use of different cognitive coping strategies. Chodoff (1970) describes that the most common defense among the German concentration camp inmates were denial and isolation of affect. These mechanisms seemed to have functioned to protect the ego against the terrors and preventing the inmates from total psychological collapse. In a field study by Anderson (1976), where the relationships between perceived stress, coping strategies and performance were examined for 93 owner-managers, whose small business's were more or less damaged by a hurricane flood, it was found that the use of problem-solving coping mechanisms was related to high performance. Pronko & Leith (1956) concluded from experimental studies that subjects suddenly thrusted into unexpected stress situations for which they were unprepared showed the greatest performance decrement. A "planted" leader situation generally had less disastrous consequences, but least disatrous behavioral disintegration, following stress, occurred when subjects were preinstructed with adequate coping reactions for handling the stress. Lazarus, Opton, Nomikos, & Rankin (1965), and Lazarus & Alfort (1964) found that subjects who where instructed to take a "denial" orientation and an "intellectualization" orientation to a threatening film showed less stress responses (GSR and heart rate) than a control group. In another experiment (Speisman, Lazarus, Mordkoff, & Davidson, 1964) it was furthermore found that the same threatening film combined with two defensive sound tracks, one inducing intellectualization and one inducing denial-reaction formation, also decreased the emotional distress of the film. Holmes & Houston (1974) let subjects in three different threat conditions receive painful electric shocks. In one threat condition the subjects were instructed to think of the shocks as interesting new psychological experiences (threat redefinition). In another threat condition the subjects were instructed to reduce stress by remaining detached and uninvolved (threat isolation). Data from self-reports, pulse rate, and skin resistance indicated in this study that subjects using these instructed coping strategies showed smaller increases in stress reactions than control subjects. In another experiment (Houston, 1973), the same author found that high trait denial subjects performed a memory task significantly better and were less physiologically aroused than low trait denial subjects in a shock-threat condition. Neufeld (1970) examined the effect of experimentally altered cognitive appraisal on pain tolerance. He found that induced denial (thinking of the pain as being pleasureable) was significantly superior in raising pain tolerance to the control condition and an intellectualization condition (thinking of the pain as being a protective reaction of sensory nerves). In two studies referred to in Houston (1977) an evaluation and a comparison of the effectiveness of different cognitive coping strategies in two different situations were performed. Intellectualization and rationalization were found to be associated with the most effective coping in both studies, whereas subjects who worried about themselves and the situation evidenced the most distress across studies.

This small sample of articles dealing with cognitive coping strategies or ego defenses emphasizes that threat defensive behavior withing normal limitations does not seem to constrict or inhibit the individual's adaptive activities but rather goes hand in hand with active efforts as part of the total coping process. Furthermore, according to Houston (1977), Sjöberg & Samsonowitz (1978), Sjöberg & Persson (1977), Andersson (1976), there seem to be differences in the effectiveness between different coping mechanisms in their properties of reducing negative consequences of affects. For example in the study by Andersson (1976) it was found that problem-solving coping behaviors revealed an inverted U relationship with perceived stress and effective performance, while mere emotional coping behaviors were negatively related to performance.

4.4. Perceptual defense/vigilance

A related phenomenon to that of coping strategies is that of perceptual defense-vigilance (McGinnies, 1949; Bruner & Postman, 1947; Postman, Bruner, & McGinnies, 1948; Erdely, 1974). This line of research suggests that the perception of external stimuli is not free from influence from internal events; i.e. attitudes, values, expectancies, affects, etc. It is a common finding here that affective stimuli may either lower (perceptual vigilance) or elevate the recognition thresholds (perceptual defense). The general explanation for this duality, according to Erdelyi (1974) is differences in personalities and consequently different modes of reacting to emotional inputs, i.e. repressors and sensitizers (Hare, 1966). However, it is also possible to propose a general curvilinear relationship between sensitivity to input and the subjective affect load of the input. Such a relationship has been proposed by Bruner & Postman (1947). Up to some optimal level of emotionality vigilance will increase, but beyond that level the affective input of the stimuli is so great that the organism, by raising the threshold, tries to keep the stimuli at som distance (see Figure 4.2).

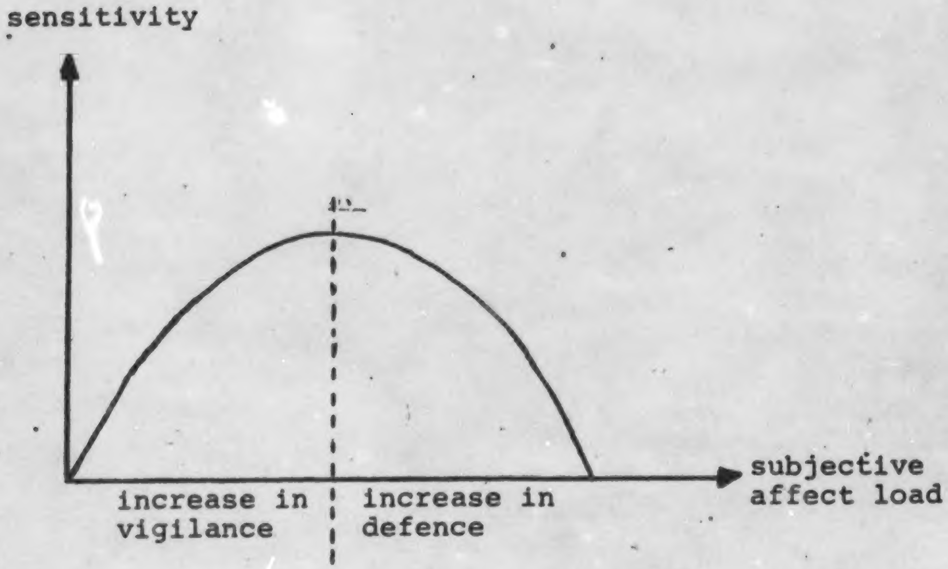

Figure 4.2. A possible relationship between sensitivity of stimuli and subjective affect load.

4.5 The role of warnings

The beneficial role of warnings and prior information before and concerning stressful events has been emphasized by Janis (1971). He referred to several studies, (i.e. Janis, 1958; Grinker, Willerman, Bradley, & Fastovsky, 1946; Cobb, Clark, McGuire, & Howe, 1954; Cramond, & Aberd, 1954; Titchner, Zweling, Gottschalk, Levine, Silver, Cowett, Cohen, & Colbertson, 1957; Janis, & Leventhal, 1965), which have shown that if normal persons given accurate prior warning and moderately fear arousing information about impending pain and danger this will function as a kind of "emotional incubation", enabling the subjects to increase their tolerance for stress by developing coping mechanisms and effective defenses. These observations made Janis propose the concept of "the work of worrying", which emphasizes the potentially positive value of moderately anticipatory fear. Failing to carry out the work of worrying may include, according to Janis, absence of anticipatory fear, absence of mental rehearsal of the impending danger, feeling of helplessness when danger materializes and increased expectations of vulnerability and disappointment in protective authorities which may, in turn, increase intense feelings of fear and anger.

4.6 Repeated exposure to threat

A further way to cope with threats, is the common finding that repeated exposure to hazardous environments decreases the emotional impact of these and makes behavior more adaptive. Research during World War II showed, according to Janis (1949), that when infantrymen first entered the front lines, they usually failed to discriminate between dangerous and non-dangerous explosions; they took cover whenever they heard any projectile. They gradually learned to discriminate, eventually taking cover only in response to sounds emitted by projectiles approaching close by. The same type of emotional adaptation occurs also among airplane pilots, scuba divers, and other who face repeated risks while undergoing training for highly dangerous occupations (Baddeley, 1972; Welford, 1974).

4.7 Learning to cope

In realizing that cognitive coping strategies in many cases are effective in reducing threats and enabling humans to function effectively in spite of these threats, it is natural to ask whether it is possible to train people using effective coping strategies.

This seems in fact to be quite possible, according to Meichenbaum (1972), who trained a group of test anxious college students with a cognitive modification treatment procedure. This procedure attempted to give an insight-oriented therapy, which was designed to make test anxious subjects aware of their anxiety engendering thoughts, which employed coping imagery on how to handle anxiety and self instructional training to attend to the task and not ruminate and worry about themselves. Results indicated that the cognitive modification group was most effective, in comparison with a desensitization group and a control group, in significantly reducing test anxiety as assessed by test performance, self reports, and follow-up of grade point averages. Following treatment, the test anxious subjects in Meichenbaum's study did not differ from a group of low test anxious subjects. Similar results with phobic patients were reported by Meichenbaum & Cameron (1973).

Furthermore, in a study by Sarason (1973) it was found that test anxious subjects who had opportunity to observe a model who verbalized while working on the test and who stated general principles, improved their performance. Under that condition high test anxious subjects solved the test even more quickly than low test anxious subjects.

In two studies, one dealing with anxiety management during the stress of flying (Girodo & Roehl, 1976), and one experiment dealing with pain tolerance (Girodo & Wood, 1976), it was found that subjects, trained to emit positive self instructions, coped more effectively with the threats.

In Girodo (1977) it is suggested that there are three different and possibly interdependent psychological processes that may be operating when people are induced to make coping self statements when exposed to a stressor: self persuation, attention diversion, and cognitively cued behavior.

Wine (1971) argued that for test anxious subjects, self instructions have their most beneficial effects because they keep the subjects away from worrying about their performance and at the same time cueing the subjects' attention to the task. In line with these proposals it was found in Bloom, Houston, Holmes, & Burish (1977) that subjects' who were instructed to read and think about an amusing story (attention diversion) were less affected by shock induced stress, as measured by various physiological measures, compared to a control group.

4.8 Conclusion

To summarize this chapter, it is shown that people use different coping strategies when dealing with impending threats. These strategies may furthermore be beneficial and promote effective functioning in spite of these threats. The role of information, prior warnings, and some optimal anticipating fear is discussed together with the effects of training. Finally, several studies show that it is possible to teach subjects to use effective coping strategies and thereby to improve their performance, despite emotional stress.

5. Individual differences in response to stress

5.1 The role of anxiety

In terms of the factors responsible for individual differences in tolerance to stress the role of anxiety seems to be unquestionable. Anxiety has generally been measured either by the Taylor Scale of Manifest Anxiety (Taylor, 1953), or the Mandler Sarason Scale of Test Anxiety (Mandler & Sarason, 1952), in the research on anxiety and stress. A very common finding in these studies is that people with a high anxiety level reveal a lower tolerance to stress, expressed mainly in a decrease of performance efficiency (Harleston, 1962; Paul & Eriksen, 1964; Russel & Sarason, 1965; Sarason, 1958, 1959, 1961; Sarason & Minard, 1962; Montague, 1953; Shephard & Abbey, 1958; Taylor & Spence, 1952; Ramond, 1953; Lucas, 1952; Harleston, Smith & Arey, 1965; Hutchinson & Cotten, 1973; Katchmar, Ross & Andrews, 1958; Sinha & Singh, 1958).

However, it is apparent from several of these studies that the relationships between anxiety level and performance is not a simple one. One interfering variable of particular significance is the level of task difficulty in the performance situation. Generally, the performance of high anxious subjects is more poor on complex or difficult tasks than on easier ones during stressful conditions. This was, for example, shown in the studies by Montague (1953) Ramond (1953) and Lucas (1952).

Attempts to account for these interactive effects of anxiety and task difficulty (or other stress factors) on performance have generally been based upon either a drive level interpretation (Taylor & Spence, 1952) or a distraction interpretation (Child, 1954; Wine, 1971). According to the drive level hypothesis high anxious subjects operate under a higher drive level than low anxious. This means that high anxious subjects will perform better during "calm" conditions, where only a single response tendency is evoked, i.e. simple tasks or non threatening situations. However, under more complex or threatening circumstances competing responses are evoked and the correct response tendency becomes relatively weaker, which means that high drive (high anxious) subjects tend to become inferior as the number of incorrect responses become greater or more dominant. The distraction interpretation on the other hand, suggests that during performance highly anxious persons divide their attention between self-centered thoughts (worry) and task-relevant variables, in contrast to low-anxious persons who focus their attention more fully on the task. The decremental effects of these tendencies are exaggerated in complex or threatening situations. However, the two theories may be quite compatible if worrying is seen as a competing response.

A neurophysiological measure, which according to Strelau and Maciejczyk (1977) is clearly related to anxiety, is CNS reactivity. This was measured, by these authors, by the alpha index, an indicator expressing in per cent the number of alpha waves present in an EEG recording made in a state of rest (i.e. total relaxation with eyes closed). High reactive persons, identified by a low alpha index, were those who, due to their higher sensitivity, reacted to the situation even though no specific stimulations were at hand. External as well as internal stimuli evoked a stronger reaction in high reactive persons than in low reactive persons. On the other hand, stimuli of the same intensity evoked in low reactive people weaker reactions than in high reactive individuals. The measure of CNS reactivity was found, in the study referred to, to be strongly related to decision making in stressful situations with pilots in flight simulation. During non stressful conditions high reactive pilots made their decisions more quickly but during stressful conditions this difference was reversed. The quality of the decisions made in non stressful situations was furthermore higher for the high reactive pilots, but the quality dropped significantly for these persons in the stress situation. There was no change in decision making quality of low reactive pilots under stress. Similar results was also found in performance on a motor task under time limitations and social threat.

Another personality trait which appears to be related to stress responses is, according to Welford (1974), Eysenck's dimension of extraversion-introversion. He argued that introverts show greater chronic arousal than extraverts. The greater chronic arousal of more introverted subjects means that, compared with those more extraverted, that they tend to be better performers under monotonous conditions, where arousal tends to sag, to be less affected by narcotic drugs, to stand up better to loss of sleep, and to have fewer traffic accidents - presumably because they are more alert. Introverts tend, in a cybernetic sense, to be self driving and make the best of their powers if not driven hard. Extraverts, on the contrary, seem actively to seek stimulation, to become optimally aroused, as it were.

5.2 Coping style and stress adaptation

Other researchers have emphasized coping style in accounting for the magnitude of reactions to stressful situations and the rate of adaptation to the stress situation (see for example Goldstein, 1973; Kragh & Smith, 1970; Hare, 1966; Goldstein, Jones, Clemens, Flagg & Alexander, 1965). In discussing this line of research, however, one should bear in mind that abnormal anxiety may constitute the base for individual use of pathological defense mechanisms (or coping styles). However, according to Goldstein (1973), individuals may in more extreme cases be divided into three general classes depending on the type of defense mechanisms they use: firstly, avoidance of threat (for example repression and denial); secondly, increased vigilance of threat (for example intellecualization, reaction formation and projection); and thirdly, non-specific defenders. He refers to several studies, which examined the relations between individual differences conceptualized this way and the reactions to various stress situations, both laboratory and natural. From these studies he concludes that the major difference between "avoiders" and the other two coping groups seems to lie in their unwillingness (a) to accept the likelihood of future danger and (b) to engage in preparatory cognitive and emotional activity necessary to keep affective arousal within a tolerable range during, and subsequent to, the actual stress event. Lacking this activity, the time between warning and stress event is used by avoiders mainly to deflect attention away from future threat, a tendency accompanied by a raising gradient of anxiety. The difference between the "sensitizers" and "non-specific defenders" seems to be in the duration of time that they remain in a vigilant stress state during the interval between a warning and actual stress event. Both accept the reality of the danger and engage in preparatory cognitive activity starting shortly after the warning, but the sensitizers remain in a vigilant state right up to the stress event with little or no dimunition of anxiety. Only specific information about the future danger shortly beforehand permits their vigilance to be used effectively during and subsequent to the stress event. The non-specific defenders, on the other hand, remain vigilant and engage in relevant preparatory activity for a limited period of time, but reduce their vigilance and arousal level as the actual danger approaches. In a state of declining anxiety they can relax their vigilance and face the danger relatively reassured.

Further light on the role of defenses and their relation to intake of information is presented in Luborsky, Blinder and Schimek (1965), where some studies are referred which have shown that the intake of information differs for people with different defences (i.e. Gardner, Holzman, Klein, Linton & Spence, 1959; Holzman, 1962; Holzman & Gardner, 1959; Luborsky & Shevrin, 1962). According to these studies, people who were inclined to use the cognitive style termed "leveling" were the ones who, most typically, used the defense of repression. (Leveling refers to the person's tendency to diminish, i.e. to "level" stimulus differention, as opposed to "sharpening" stimulus differentiation). Another cognitive style, "scanning", was found to be associated with the defense of isolation - people who were extreme scanners were found to be extreme isolators. The concept of scanning refers to a deployment of attention to many aspects of a stimulus field, and a preference for differentiated experience of the world.

In Luborsky, Blinder and Schimek (1965), the question was asked whether these relations between cognitive style and defenses might be a product of special ways of looking at the stimulus field. And in fact they found that the defense of isolation was associated with venturing to look around more, and the defense of repression with looking around less. In contrast to repressors, isolators looked at the "ground" as well as the figure, they scattered their fixations and they made bigger jumps from one fixation to the next.

The fact that certain defense mechanisms may be related to neuroticism or other mental abnormalities has led Kragh, Smith and co-workers (Kragh & Smith, 1970) to develop the Defense Mechanism Test (DMT). This test can be defined, according to Kragh (1970), as a projective method in which a percept-genetic, tachistoscopic method is used, and the subjects' reactions to these stimuli can be interpreted as various types of defensive organization. This instrument has been used as a method for selection of aviation cadets (Neuman, 1978) and attack divers under the assumption that subjects in whom defenses are constantly at work should also have difficulties in resisting the stress of the military training and increase the subjects' casualities. The results of these studies have shown that the DMT is probably well suited for predicting success of various types of personnel working under conditions of stress.

5.3 Individual differences in "time-sharing ability"

Finally, we shall briefly discuss individual differences in "time-sharing ability" which may be interesting for man-machine applications. An important and probably also very stressful characteristic of for example modern flying is the urge for adaptability to quickly changing situations. There is also a need for a capacity for integration and processing of information from several sources. According to Jennings and Chiles (1977) there are reliable individual differences in how well operators can "schedule" their work so as to minimize the interference between different tasks, and these individual differences are rather independent of the levels of skill exhibited on the component tasks when performed by themselves. Validation studies of a test for "dual-task performance" (North and Gopher; 1976) supported the views by Jennings and Chiles. They found three dimensions of consistent individual differences. One was the ability of subjects to perform a single, focused-attention task with a gradual increase of task difficulty. A second was the general ability to cope with divided-attention and time-sharing requirements. The third dimension was the ability to voluntarily adjust and reallocate attention with changes in task priorities. The last two dimensions reliably correlation with flight performance, comparing flight instructors' and students' samples and students' performance in flight training.

5.4 Conclusions

In summing up this brief review on individual differency in response to threat if is shown that anxious people seem to be more influenced by emotional stress as reflected in performance, particularly on complex tasks. It is also proposed that there exist individual differences in the use of coping strategies in dealing with threatening conditions, which in turn may have consequences for effective functioning under such circumstances. And, finally, "time-sharing ability" is discussed as a factor of individuals when working in complex and stressful situations.

6. Discussion

In order to obtain more coherent understanding of the research reviewed so far, it might initially be appropriate to present some general theory of the emotional process and how emotions influence human functioning. Naturally, this is not an easy endeavour, and at this preliminary stage it might be more suitable to talk about a possible description of the emotional process, and furthermore some restrictions have to be made: Firstly, this is mainly an attempt to give the reader a summary of the emotional processes and influences from what is possible to discern in the various reports reviewed. This means that the description is biased in the direction of the special aim of this article. Several facets of human emotional functioning are excluded. In addition, due to the general purpose of the review, which is presented in the introduction, the description is mainly concentrated on the process and influence of negative emotions, particularly fear and anxiety.

6.1 A general description of the emotional process

A good start in such a description is, according to the authors, to ask oneself about the psychological origins of emotions. E.g. what is the cause of a special feeling, for example negative ones, like various types of unpleasantness? The answer to such a question could be stated rather straightforwardly. When various individual strivings are frustrated or are believed by the individual to be frustrated, a negative emotion is the result. Both everyday experience and more sophistifacted psychological theories give credence to such a proposal. What differs is, however, the given content and meaning of these "strivings"; in ordinary language they are often called wishes, and a behaviorist may call them drives. Other terms are motives, motivations or values. Sometimes no clear distiction is made between motives and emotions or between values and motives. However, is it possible to summarize all these different concepts under the heading of strivings. Regardless of the different contents it is also well documented that frustrations, blockings or interruptions of these strivings usually result in negatively toned feelings.

In this context we prefer to use the term wishes in accounting for these strivings, mainly for two reasons. It is the word commonly used by people to describe what they want or do not want to do, to be, to become, etc. Furthermore, it is in the shape of more or less concrete wishes that strivings enter human consciousness, where it is possible to evaluate and express them. However, this does not mean that the strivings may not influence human functioning also on unconscious levels, but certainly in a more diffuse and unpredictable manner. It may be convenient for the present purpose to characterize the origin of wishes as one or several basic needs states. These needs become, during the ontogenetic development and socialization tied to more or less specific wish contents, depending on the particular environment and resources characterizing the special individual. This means that a particular concrete wish may vary in the appropriateness by which it can satisfy a more basic need, once again depending on what the unique individual has experienced and what he believes about himself and his environment. However, the structure of wishes that the individual has, is usually in imminent flux. Their phenomenological contents and degree of importance are usually changing in accordance with the individual's beliefs about the environment and himself, and what he thinks is good for him. Furthermore, some wishes may be subordinating to other wishes given higher priority and others may be conflicting with each other. Wishes also vary in subjective strength.

The individual evaluation of wishes, according to their degree of importance is dependent on the same evaluations made by significant people surrounding the particular individual. Commonly the individual's evaluations of his wish structure is also influenced by the general evaluation made by society, because the awareness of the societal evaluation is one of the determinants when the individual shapes his own value structure. However, this is definitely not always the case particularly not in loosely connected or heterogenous societies.

The strength of wishes is furthermore an important factor in determining the degree of emotional stress experienced when wishes are frustrated. Frustrations of strong wishes result in more emotionality than frustrations of weaker ones.

The frustrations of wishes may depend on two classes of factors; environmental and individual. Environmental factors are evoked when the subject, realistically or not, makes the judgment that either physical or psychological obstacles in his environment blocks the execution of his wish. Individual factors are evoked when the subject judges that his individual resources are the limiting factors. It is important to realize that these judgments may vary in their correctness. Beck (1976) has for example convincingly argued that much of emotional disorders depends on chronic misperception and faulty imaginations of threats and coping resources. However, we shall not here discuss the sources of such faulty judgments, but only state that they are mainly to be found in development and socialization. And chronic frustration and thereby chronic emotionality is not always a function of faulty judgments. For example, individuals with wish structures dicrepant from what is high-valued in their society necessarily become more frustrated than others. Furthermore, socieites, built up of several subgroups with different evaluations of wish structures, are also societies with much emotional wear and tear. A society can also influence emotionality in their members by not providing enough opportunities for their members to carry out their wishes, despite their high societal value.

Thus, to summarize, so far it is proposed that emotions are states resulting when high-valued wishes are believed by the individual to be frustrated or satisfied. A similar proposal has also been made by Simonov (1970, 1975), who from a more neurological point of view writes that "... a given emotion (E) is the reflection in the brain of the more developed animals and man of the value of a certain need (N) and of the probability of its reduction" (Simonov, 1975, p. 47). That judgments are important contributors to emotional experiences has also been recognized by several other researchers (i.e. Arnold, 1970; Lazarus, 1966; Schachter & Singer, 1962; Mandler, 1975).

Having in general terms depicted the origins of emotions, the turn has come to describe the characteristics of these states. And, for reasons already mentioned, the description is concentrated on the negative ones, i.e. unpleasant states. The general difference between emotional states as described above and neutral states is the increased activation of the organism and the re-direction, both psychological and behavioral, of efforts toward the sources of frustration. The increased activation is particularly illustrated by the increase in physiological arousal level. Tendencies to direct the activity toward the believed causes may include rapid sequences of thoughts like "how did this happen and what shall I do now", and in more extreme cases behavioral tendencies to physically attack or escape the obstacles. In more concrete terms the emotional state may be characterized as follows:*

(1) Raised physiological activity, particularly via the autonomic nervous system.

(2) Increased cognitive activity toward the sources of the "emotional judgment" and toward possible ways of coping.

(3) Raised attention toward cues phenomenologically associated with the emotional state.

(4) Reduced attention to cues which are not phenomenologically experienced as related to the emotional state.

(5) A tendency to make faster decisions an actions.

These characteristics are different, but interdependently related facets of the emotional state. They activate and direct the organism toward the frustration and satisfaction of his wishes. But it is generally agreed upon that the adaptability of emotions is not a linear function of the emotionality experienced. Generally it is suggested that the best judgmental and adaptive capacities are assessed during conditions where the emotional stress is in the intermediate range. To put it in another way; extremely low stress and extremely high stress are likely to give rise to defective information processing, whereas intermediate levels of stress are more likely to be associated with vigilant information processing. Whether low, intermediate or high emotional stress is experienced is, however, depending on the cognitive and decisional processes made when individuals confront their wishes with the possibilities of satisfaction and frustration. A very interesting description of these, usually very hasty, judgments, and their emotional and adaptive consequences, has been presented by Janis and Mann (1977). They suggest that when a person is confronted with some threatening information, the first basic questions are of the type "Is this serious? Do I

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* How these characteristics of the emotional state may influence general information processing and performance was reviewed in chapter 3.

have to take action?" (see Figure 6.1). If the answer to these questions is "no", little or no emotional arousal will be evoked, and at the same time very little of vigilant information searching concerning the threat and possible ways of coping with it will ensue. Sometimes, of course, such an appraisal may be quite realistic and justified, but with the definite answer "no" to these questions the possibilities of finding out if an error has been made before it is too late have been ruled out. However, if the answer to the first question is "yes" or "maybe", the person will become more emotionally aroused and he will seek more vigilantly for more information and possible action routes. In doing this, he asks himself the second basic question: "Are there any serious negative aspects if I take the most available action route?" If the answer to this second basic question is a confident "no", this state of arousal will subside and he will promptly start to carry out the protective action. Also, in this case, relatively little emotional arousal will be evoked and consequently too little of thorough information searching. If the person's answer is "yes" also to the second basic question, the person's aroused emotional state will not subside and will become more intense. Janis and Mann postulate that as soon as a person gives a "yes" answer to the first two basic questions, he asks himself a third basic question; "Is it realistic or possible to find a better action route?" If his answer to this basic question is a definite "no", the person will pessimistically give up searching for a better solution, despite being dissatisfied with the options open to him. Instead of vigilant search his dominant mode of coping with the emergency will be to avoid cues that may further stimulate anxiety or other unpleasant feelings. This defensive avoidance pattern can take a number of different forms. One involves a defensive lack of interest in the problem posed by the emergency information; the person becomes selectively inattentive to threat cues and avoids thinking about the possible danger by distracting himself with other activities, like taking drugs or developing fatalistic beliefs that support a precariously optimistic outlook. According to Janis and Mann (1977), extreme examples of this form of defensive avoidance have been observed among military personnel who have spent many months in combat. For example, when they lose hope of being removed from the front lines after witnessing the death of many friends, infantrymen who are "old" in combat experience develop a set of symptoms known as the "old seargeant syndrome". They decide not to take cover during artillery attacks and ignore other elementary safety precautions, having become fatalistic or apathetic about the dangers of combat.

Closely related to this evasive form of defensive avoidance is "buck passing", i.e. depending upon someone else to make the decisions what to do. The person may rationalize that others know better than he how to make the right choice or that the problem is in some else's bailiwick.

Another form of defensive avoidance consists of ignoring the available information about the defects of the least objectionable action route and developing rationalizations

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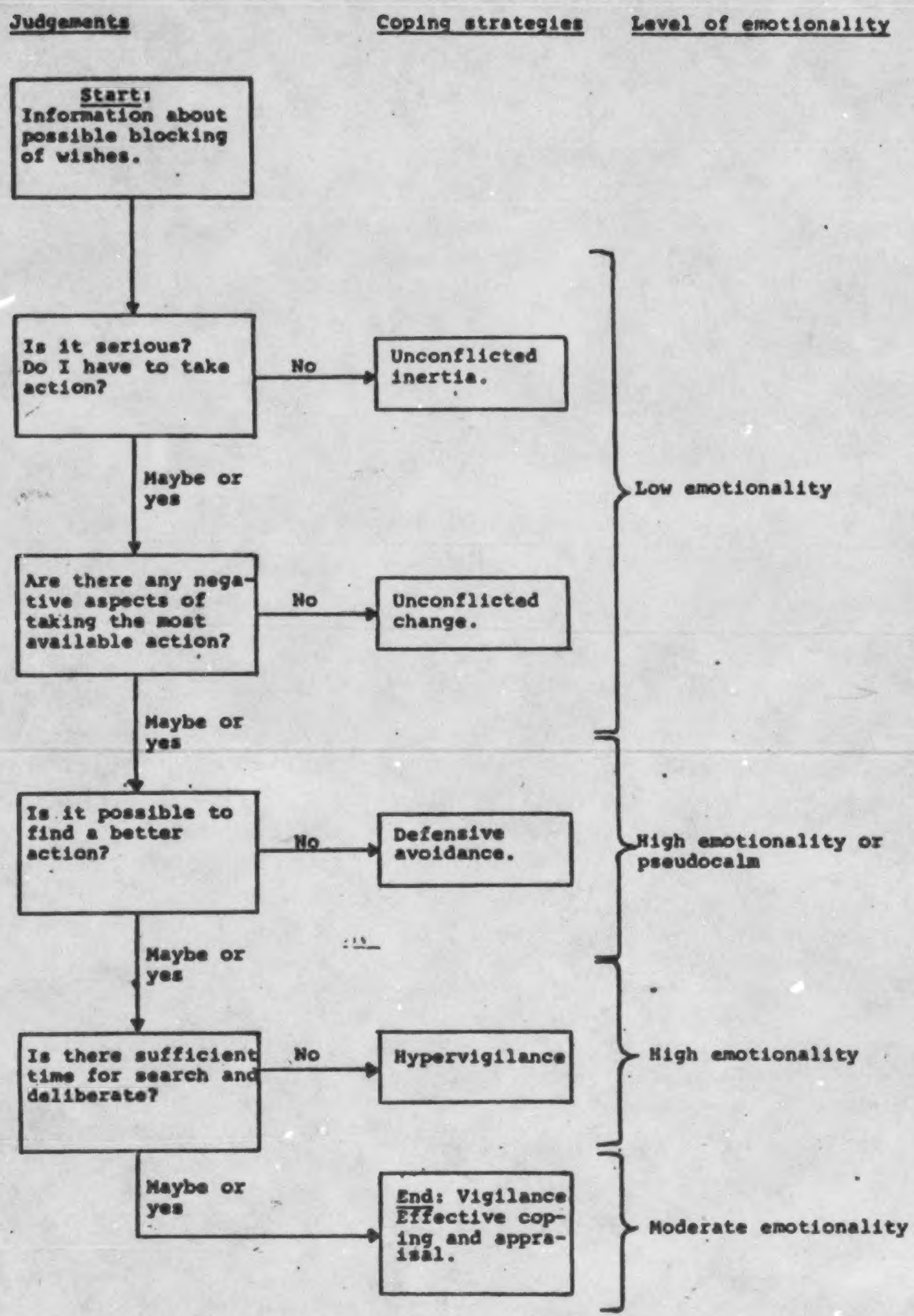
Judgements
Coping strategies
Level of emotionality
Start: Information about possible blocking of wishes.
Is it serious? Do I have to take action?
No
Unconflicted inertia.
Maybe or yes
Are there any negative aspects of taking the most available action?
No
Unconflicted change.
Maybe or yes
Is it possible to find a better action?
No
Defensive avoidance.
Maybe or yes
Is there sufficient time for search and deliberate?
No
Hypervigilance
Maybe or yes
End: Vigilance Effective coping and appraisal.
Low emotionality
High emotionality or pseudocalm
High emotionality
Moderate emotionality

Figure 6.1. A model of the judgemental process of wish-threatening information. (Basically adapted from Janis and Mann, 1977, p. 55).

that argue against evidence of its potentially unsafe features. The emotionality originating from these judgments is predominantly high, or at least "pseudo-calm" if the defensive avoidance is effective to some extent. In the short run such defenses may be functional in keeping the threatening information at some psychological distance, but certainly not in the long run because it withhelds the person from a more thorough and vigilant search of effective coping actions.

However, if the person believes that it is possible to find a better action route, he probably asks himself the question: "Is there sufficient time to make a careful search for and evaluation of information and advice?" Realizing that it is essential to find a reasonably safe action route and expecting that a satisfactory one can be found, the endangered person becomes very emotionally excited as he believes that he is confronted with an imminent deadline, a kind of hypervigilant information searching will be evoked. The most extreme form of hyper vigilance, popularly referred to as panic, occurs, for example, when people are confronted by rapidly approaching fire, believing that it is possible to escape, but can see that the escape routes are rapidly being closed off. During such conditions the individual makes a very rapid survey about the situation and a snap judgment about the best thing to do, often being unduly influenced by what people around him are trying to do. He may also fail to use whatever time he has to try to find the safest exit, which requires taking account of many complexities, such as whether the number of people is so large that their convergence on one exit will create a blockage. Thus, these judgments cause an extremely excited emotionality which in turn brings the person toward too much focusing and too rapid and simple-minded decision rules as "do whatever the others around you are doing."

On the other hand, if the threatened person maintains a hope of being able to cope effectively and continues to believe that he has sufficient time to find a safe way out, his emotionality probably persists in a less excited form. His pattern of coping is probably characterized by careful search and appraisal of effective action routes. This is also a pattern of coping that is most adaptive. While the person exhibiting this vigilant form of search and appraisal has realized the danger and also makes the judgment that it is possible to find a good way out, his emotional arousal is intermediate and optimal.

The model proposed by Janis finally specifies under which conditions this most adaptive form of searching of information dealing with threats and how to cope with the threat will be fostered:

(1) Awareness of possible threat if no protective action is taken.

(2) Awareness of possible risks if the most available action is taken.

(3) Moderate or high degree of hope that a search for information and advice will lead to a better escape route.

(4) Belief that there is sufficient time to search and deliberate before any serious threat will materialize.

Certainly, in many circumstance one or several of these conditions may not be fulfilled depending on environmental or individual restrictions. For example, it may be quite plausible in some situations that it is objectively possible to take just one very riskful route of action, but to be definitely sure that it is so, it is necessary to vigilantly scrutinize the possible existence of other alternatives. The most interesting aspect of Janis's model is the description of the emotional states as consequences of different judgments, and implications of the judgments for the character and functional value of these states.

6.2 The general adaptivity of emotions from a cognitive point of view

From a cognitive psychological point of view the human mind may be regarded as an organized processing system of structures that operates on the input from the external and internal world. These structures interpret the world including any and all perceptible events whether they take place inside or outside the skin of the actor. In this meaning the system provides the effective, interpreted cues for action and interpretations and characterizations of the environment. Naturally, the system processes input from the sense-organs, but it is also self-generating in that it contains programs and transformations that, under given circumstances will seek information and add information when such is lacking from the external world. Furthermore, this cognitive system constructs organized action sequences and supervise their executions via higher-ordered plans (Miller, Galanter, & Pribram, 1960). However, in this context it will lead too far with more detailed reviews of models of human information processing, but instead ask the question about the place of emotions in such models.

Mandler (1975) suggests that the interruption of organized action sequences and plans, whether they are sheer cognitive (thoughts) or behavioral, produces a state of arousal that, in the absence of completion or substitution, then develops into one or another emotional expression, depedning on the occassion of the interruption. And an interruption occurs when a current structure fails in handling available input or action requirements. In this sense interruptions become important because they signal important changes in the environment, which often lead to altered conditions of living, adapting and surviving. Furthermore, one of the main avenues for change in existing cognitive and action systems is undoubtedly a consequence of the failure of existing structures. Mandler also writes that the fact that arousal comes into play whenever current activity is maladaptive can be seen to have important survival values. These can be considered from two points of view,

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according to him: First, arousal has preparatory flight and fight functions. These functions are of primary value whenever the organism is engaged in activities essential to species' survival, such as food seeking, the protective organization of the groups, etc. (wish implementation in our terms). Secondly, the arousal results in increased attention and information seeking toward the interrupting obstacles and possible means of completion, substitution or cognitive change. He suggests further that since onset of interruption is, by definition, unexpected, and since the organism frequently has few other situationally relevant responses available or high in his repertory at the moment of interruption, it is this lack of environmental control, this "helplessness" in the face of interruption, that is responsible for the high frequency of negative affect in response to interruption. In this way it is possible to understand the negative affect, for example fear, as a mixture of both arousal, as a consequence of interruption, and cognitive attempts to interpret the interruption and finding ways out of it. Thus, while fear is not a necessary consequence of interruption, it is in most conditions a highly likely one.

In making a final comment on Mandler's view, as interpreted above, the similarities with the model proposed by Janis are obvious.

Another prominent psychologist who regards the human mind as an organized system of information processing is Herbert A. Simon. He regards the human mind as basically a serial information processor, whose activity toward specific goals, when it is not blocked, is terminated by aspiration, satisficing, impatience, and discouragement mechanisms, and that distinct tasks may be queued or handled within individual time allocations (Simon, 1967). However, he also suggests that these mechanisms are inadequate to deal with the fact that the environment places important and sometimes severe, real-time demands upon the system. In a queuing system, for example, if a new goal is evoked, it is placed on a waiting list until current goal programs have been terminated. In a mild, benign environment, a leisurely response of this kind may be adequate, but in the real world, it sometimes is not. An interruption mechanism that allows the processor to respond to urgent needs in real time is necessary. The properties of this interruption mechanism are, according to Simon, usually ascribed to emotion, which in turn functions so as to evoke a new urgent goal-oriented chain of activity.

As the reader probably has noticed there is a difference between the proposals made by Mandler and those made by Simon. While Mandler views emotion as consequences of interruption of ongoing activities. Simon regards emotions as qualified to interrupt ongoing activities. This may seem contradictory, but not if you assume that the human mind contains several goals (strong wishes) and that different plans and organized action sequences are developed for the implementation of these wishes. Although it is reasonable that the human mind is organized toward the implementation of one wish at a time, it is not unaware of the other wishes and the possibilities of their blocking. Thus, emotions may be aroused, both when the execution of one wish implementation is interrupted and when the subjects judge that their momentarily resting wishes may be blocked. In both cases the characteristics of the emotional state will be evoked, i.e. arousal and redirection of attention and cognitive activity. However, these proposals require that a certain amount of processing must go on continuously, or almost continuously to enable the system to notice when conditions have arisen that require ongoing programs to be interrupted.

In a way such views, which regard the human mind as a processor of sequential chains of actions, may be critized as being too "automatical", a criticism that may be valid when recognizing that humans also have a tremendous capacity of imagination. We are able to remember situations in the past and also how we felt in some of these situations, and furthermore, this remembering activity lies behind the imagination of situations and their concommitant feelings in the future. In this meaning emotions may be important factors in the imaginative planning of appropriate action sequences. Persistent, goal-directed activity has to be motivated somehow and it may be not enough for a soldier, for example, to note in "cold" information processing terms; "OK, there may be a risk of being wounded on that mission, but I'm going to do it becaase it is a good way to satisfy my important wish to be brave." In such situations the highly sophisticated perceptual and cognitive resources, characterizing the mind, would have little survival value if they had not involved some "hot" motivational qualities as well. What probably is required as well is some kind of motivational quality indicating states of more or less intense feelings of umpleasantness or pleasantness; states that are sufficiently powerful to override strongly organized activities of wish implementation and, via imagination, to govern and motivate activities toward wish implementation. Thus, what is stated here, is that emotions, and images of situationally related emotions, also are important factors in producing the goal-directedness of behavior and mental activity, because of the emotional properties of being subjectively unpleasant or pleasant. This can be understood by the simple realization that we in many occassions just do what we like to do (it gives us a pleasant feeling) without any conscious reflection about the underlying wish.

A striking illustration of the adaptational and motivational qualities of "hot" subjective feelings is given in a study referred to by Mandler (1975) of human beings afflicted with congenital analgesia (Fanconi & Ferrazzini, 1957). This apparently inherited syndrome consists typically of a complete absence of pain sensitivity, despite otherwise normal registration of the environment. Despite the fact that such patients cognitively can judge which activities that may be dangerous for the body, they commonly fail to develop specific adaptive avoidance behavior in the face of many injuries and noxious situations. Thus, it seems to be necessary for adaptation that the "cold" cognitive judgments are combined with "hot" feelings (pain, emotions, sexual excitement, etc.) if they are to be efficient in regulating action. Bearing this in mind, it might be interesting to put oneself the question how humans psychologically and socially would function on a purely cognitive basis, that is, without emotions of any kind.

6.3 When emotions are dysfunctional

So far, emotions have generally been described as adaptive, and this is probably true in most occassions. Despite this, is it also true, and well-credited from many points of view, that they in many cases are not. But it will be argued here, that in such cases it is not the emotions that are dysfunctional, but rather the cognitions and environmental circumstances that have developed and caused the emotions that are dysfunctional

In discussing this in more detail, it might initially be appropriate to summarize what was suggested in the beginning of this discussion about the origins of emotions. It was said that emotions were a consequence of frustration or satisfaction of strong wishes. Logically, this statement implies that the degree, quality and frequency of occurrence of emotions depends on the organization of wish structures. It is certainly so that all wishes are not equally good in satisfying more basic needs, or are equally easy to carry out. If an individual, depending on faulty learning, has strong wishes that either are bad means of satisfying basic needs or very difficult or impossible to satisfy, he will sooner or later meet emotional problems. Let us illustrate this with an example: The activity of smoking is a consequence of a wish to smoke. This wish is usually developed in youth when it may be regarded as a means of satisfying a more basal wish of being independent and mature. However, objetively, smoking is a bad means of satisfying this more basic wish, particularly when regarding all the negative physical aspects of smoking. Realizing this, the wish to stop smoking may arise, but this is usually not easily done without emotional strain. These emotional problems are caused only be an inappropriately learned wish. Related to this example is the ease when strong wishes are conflicting or contradictory to each other. Such conflicts necessarily result in emotions because of the fact that implementation of one wish includes the frustration of the other.

A special case of inappropriate wishes is when the avoidance of certain emotions, or when the striving for other emotions, becomes the most high-valued wish of all. Under such circumstances the individual's wish structures may center on only what is perceived as unpleasant or pleasant in the short run, devoid of any relations to more basic values and needs. As examples of this one might refer to some very wealthy and "satiated" persons' intense search of new extacies and pleasures (the Jet Set syndrome) or to people who are so afraid of pain that they refuse to search medical help.

In realizing that faulty wish structures may develop into emotional problems one also understands the necessity of flexible re-structuring of wish structures in cases of frequent frustration. Thus, the individual must also have capabilities to change an inappropriate wish to more appropriate ones, in order to avoid chronic emotional problems. It is also true that people in many occasions lack such possibilities, depending on various individual or environmental factors. As examples of such individual factors one might notice the fact that people, depending on their particular socialization, sometimes have very restricted and rigid views on matters of good and bad, life quality, choice of career, etc. Restricting properties in the environment that result in difficulties to change wish structures can be of many kinds. Commonly, wishes and actions results in commitments that often make it very hard or difficult to change to a new course of action.

It was suggested earlier in this discussion that the emotional state also was dependent on the decision process made when individuals confront their wishes with their possibilities of satisfaction and frustration. This indicates also that the adaptive occurrence or nonoccurrence of emotions depends on the correctness of this decision process. Thus, it is obvious that an emotion, for example fear, is dysfunctional when it is caused by a fancy imagination of threat. In Beck (1976) ample evidence is given that much of emotional disorders are dependent on thinking aberrations, like exaggeration, overgeneralization or absoluteness. Let us for example take the maniac, whose extactic mood may depend on the faulty judgment that everything he wants is possible, or the paranoid, whose extreme feelings of persecution may depend on the belief that all humans are evil.

Such inappropriate judgments may refer to the environment, but they may also be judgments about coping resources. It is suggested that although the judgments about the environment may be correct, judgments about subjective coping resources have to be realistic as well, if emotions are to be adaptive. People with chronically low self-esteem may be taken as examples showing such, usually, non-realistic judgments.

So far, emotional problems have been explained as consequences of inappropriate wishes and judgments. But one can not deny the fact that emotions may be problematic, despite appropriate wishes and correct judgments, simply because that coping possibilities under the influence of emotions are restricted. Such a situation can be illustrated by the soldier, who is isolated in the front lines without any possibilities to take more cover than he has done, with the highly appropriate wish of not getting wounded or killed. Naturally, the adaptivity of strong emotions in such situations may be questionable, but it might be better to question the adaptivity for human survival of this situation. However, neglecting this question here, one might suggest that the mechanisms of defensive avoidance, discussed earlier by Janis, are put into play in such situations with the functional value of decreasing too much of emotional arousal. Thus, defensive avoidance may be adaptive for the individual in such situations. And, finally, under emotional strain, the efficiency of cognitive processes very probably diminished. This adds to the burden of the individual and very often makes it more difficult for him to cope efficiently.

To summarize, it has here been discussed under which circumstances that emotions may be dysfunctional. A natural continuation of this discussion is to give some suggestions how to compensate for dysfunctional emotions.

6.4 How to eliminate the occurrence of dysfunctional emotions

In order to decrease nonadaptive emotions, it is important to give the individual opportunities to develop sound and flexible wish structures. With sound wish structures is meant, firstly that they rather straightforwardly are related to basic needs (for example those suggested by Maslow, 1962), secondly that they have plausible opportunities to be carried out. This in turn, is in the first hand a question about good socialization and learning, i.e. a society that teaches their members good means of living, and wishes that are shared and high-valued. It is also a question of giving plausible opportunities to most members in the society to carry out these high-valued wishes.

Furthermore, it was suggested that an individual must learn to be flexible in developing and implementing his wish structures in cases of individual and environmental change. However, this is not to propose the adaptivity of always giving up in all cases of blocking of wish implementations. On the contrary, the existence of an influential and strong wish may in many occassions help the individual to neglect or resist the emotional effects of the blockings of relatively lower-ordered wishes. Such influential and strong wishes were, for example, found by Sjöberg and Samsonowitz (1978) in some smokers, who succuuded to quit smoking. They stated: "To keep an action going in the face of conflicting wishes it seems that one needs to invest the action with energy. This energy might have its source either in values or in emotions that make the action attractive or alternative actions aversive. By a relevant choice of values (e.g. self-esteem) and wishes one may, in this way, invest the action with the needed energy." (Sjöberg & Samsonowitz, 1977, p. 16) Lewin (1948), pointed to the fact that the individual wishes have to be shared and high-valued also by his society if they are to function as mechanisms of sustaining to a given action despite conflicting or interrupted wishes, characterizing an individual. He writes: "Only by anchoring his own conduct in something as substantial and superindividual as the culture of the group, can the individual stabilize his new beliefs sufficiently to keep them immune from the day-to-day fluctuations of moods and influencies to which he, as an individual, is subject" (Lewin, 1948, p. 59).

One way of counteracting the emotional consequences of possible blocking one one wish in a situation, is a repertoire of relevant values that counteract the original wish. Take for example the soldier who does not carry through the action of desertion, which may be a natural implementation of the strong wish of not getting killed, because he has an even stronger and conflicting wish and value of bravery, saving his country, fighting for liberty, etc. History also gives ample evidence to the fact that soldiers with such values (described as fighting morality) also in most cases are effective soldiers.

However, emotions are also dependent on judgments, as to what may be threatening or satisfying. And some of these judgments may be more or less incorrect or grounded on imagination. Despite this, they may arouse different kinds of emotion, which under such circumstances obviously are of less value, or may even be dysfunctional. Consequently, to teach people to make appropriate judgments about threats and personal coping resources implies that emotions, caused by incorrect judgments to a greater extent are excluded. Such learning was for example observed by Janis (1949). He stated that when infantrymen first entered the front lines, they usually failed to discriminate between dangerous and non-dangerous explosions. They took cover whenever they heard any projectile. But gradually they learned to discriminate, eventually taking cover only in response to sounds emitted by projectiles approaching close by.

However, as a consequence of past experiences, some people are chronically biased in their judgments about the existence or non-existence of possible threats. One general characteristic of very anxious people, for example, is the fact that they regard too much of their environment as potentially threatening to them. And, at the other extreme, one might find people who chronically fail to, or neglect to, registrate what might be potentially threatening. It is obvious that such personality characteristics may be fatal in situations where it is important to make correct judgments about risks, for example, flying. This fact has led Neuman (1978) and others to develop and apply the Defense-Mechanism-Test in the selection of military pilots.

Very related to the learning of making accurate judgments is the necessity of knowledge about threats and subjective reactions to threats. In chapter 4, several studies were referred to, which showed that if normal persons were given accurate prior warning and information about impeding pain and danger, this functioned as a kind of "emotional incubation" (Janis, 1970), enabling the subjects to increase their tolerance for stress by developing coping mechanisms before the threat materialized. Failing to carry out this "work of worrying" properly, may include, according to Janis, inappropriate anticipatory fear, inappropriate mental rehearsal of the impending danger, feelings of helplessness when danger materializes and disappointment with protective authorities, which may in turn increase intense feelings of fear and anger. Janis also suggests techniques of promoting this "emotional inoculation" (Janis & Mann, 1977), which includes cognitive and emotional confrontation with impending, threatening situations, e.g. emotional role-playing.

Naturally, it is in many cases not enough to have accurate wishes or to make fair judgments about possible threats and subjective reactions. It is also important to obtain a repertoire of appropriate coping strategies in cases of possible threats, and to be aware of these possible coping strategies.

One obvious coping strategy is the use of concrete actions to eliminate threats. Take, for example, the pilot who has learned in detail how to deal with emergency situations. Thus, a repertoire of easily performed and threat-eliminating action-routes is an obvious and straight-forward way of avoiding dysfunctional emotions. This statement may seem to be trivial, but it is nevertheless well-credited that much of emotional distress depends on the fact that people had never learnt what to do in cases of potential threats. However, in many occassions it is more difficult to execute some well-learned, threat-eliminating actions, due to internal and external constraints. In such cases inadequate emotions have to be controlled by entirely cognitive strategies. One such strategy may be the one just discussed, namely change of wish structures or to bring some very important value to mind. Other purely cognitive coping strategies, like self-persuation, were discussed in chapter 4. Many of the reports discussed there, also show that such coping strategies may be effective in reducing emotional stress. It was also stated that it is possible to train people to effectively use such coping strategies. However, it should be clear that some strategies are more problem-oriented than others, that are more efficient in just keeping emotional distress under control in the short run.

Relaxation should also be mentioned here as a coping mechanism, since physiological arousal is one very important characteristic of emotions. It is a well-known fact that various relaxation techniques help people to keep calm and more confident in threatening situations.

Thus, to summarize, different factors that may eliminate the occurrence of dysfunctional emotions, the following points can be made:

(1) Appropriate wish structures; i.e. wishes that are straight-forwardly related to basic needs, and wishes that are possible to carry out.

(2) Wish structures that are flexible; i.e. wish structures that smoothly change in relation to definite changes in the context of possible implementations.

(3) Use of strong values that may function to sustain to a given action despite conflicting wishes.

(4) More realistic judgments of threats and coping resources.

(5) Anticipatory knowledge about possible threats and emotional reactions.

(6) A repertoire of appropriate coping strategies, which may include:

  (a) knowledge about action routes to eliminate the threat;

  (b) cognitive coping strategies;

  (c) techniques of relaxation.

Let us now finally offer some implications of this lenghty review to the discussion of man-machine systems.

6.5 Implications for man-machine systems

Let us start this with a very brief description of a typical man-machine setting. Man's place in such systems is, firstly, to scan in an attentive manner the information input from the machine with the help of certain criteria. Secondly, to analyze this information according to some criteria. Thirdly, to execute some proper action in the machine. However, these sequential steps may be very hard to separate, while they are processed continuously in feedback-loopes, interacting with the machine.

One fact that distinguishes man from the machine in such systems, is that he is never totally unaware of what is or has happened outside or inside him, i.e. awareness of information that is not related only to the effective processing of the machine-system. And if this unrelated information processing becomes too comprehensive, it has debilitating effects on the information processing related to the man-machine system, particularly if the latter is complex and in need of much of the total cognitive capacity.*

One such very important interfering factor, that requires large amounts of available information processing capacity is the notion of possible frustration of strong wishes and the concommittant emotional states. How these emotional states, particularly negatively toned ones like fear, may influence information processing in performance situations, has been reviewed in chapter 3. In this context the purpose is to apply these findings to man-machine systems.

Let us first discuss the sequence of scanning or attention of the informational input from the machine. Several studies in chapter 3 suggest that attentional capacity is lowered as a function of emotional arousal. It has also been shown that physiological mechanisms, such as eye accomodation and pupil size are affected by emotional arousal. But, it is also suggested that this decrease of attentional capacity is not uniform. On the contrary, the responsiveness to central cues may be increased at the cost of decreased responsiveness to peripheral stimuli. However, these "central cues" may denote different things. Firstly, they may be stimulus displays that are physically central to the operator:,secondly, the attentional tasks that are most relevant for the performance; thirdly, cues that initially attracts the greater degree of attentional focus; or, fourthly, cues associated with a high error probability; and, finally, probably also cues that are physically more outstanding. (In most practical settings, however, these different features of centrality occur together). This direction of attentional capacity toward the central cues may be illustrated by the phenomenon of "goal-fascination" observed among military pilots. It seems not to be uncommon that fatal flying accidents occur because the pilot becomes so fixated on the "central" task, such as following a goal, that he completely forgets other changes surrounding him.

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* It should be stated that although emotions generally are adaptive for human functioning, they may be interfering factors in the effective functioning of a particular man-machine system.

One important question concerning this reduced or re-directed attention is whether it is a function of changed subjective criteria or of reduced processing capacity. Although that Bacon (1974) suggests that the stimulus loss under arousal represents an actual diminuition in the subject's sensitivity, it is probably also a question of changed criteria, in this case, learned criteria of what is important fo focus the attention to. The study by Hockey (1973) in which the subjects were required to monitor three sources of signals, indicating occasional faults in a machine system, may indicate this. He found that increased arousal produced an increased sampling of the sources associated with a high fault probability. It was also found that arousal increased the tendency to make more definite decisions (hits or misses) about the need for a fault to be corrected. Also, the study of Wright (1974), where he found that under high time pressure and distraction, subjects tended to attend to disproportionately more negative cues in making their decisions, may indicate a change in the criteria. However, so far it is impossible to say whether reduced attention to peripheral stimuli is an effect of reduced processing capacity or changed criteria. Erdelyi (1974) provided extensive evidence that attentional selectivity is brought into play through varied mechanisms at multiple loci of the information processing sequence, which suggests that both criterion change and processing capacity loss may occur.

However, if the emotional state becomes very intense and urging, it is plausible that attention to even more central cues in the machine setting decreases (i.e. Easterbrock, 1959). Thus, increased emotional arousal initially results in decreased attentive capacity toward peripheral stimuli, while attention toward the central ones may even be increased, at least if the emotional arousal does not become too strong. This implies that man-machine systems, where the operator has to attend to many sources of information, or when he has to simultaneously watch over different groups of information cues are more susceptible to emotional influence, particularly if the stimulus sources are subtle, complex, or hard to detect. It is also suggested that machine settings that require the operator frequently to switch attention from one stimulus display to another, for example military fying where the operator commonly has to handle the plane and executing some strategic mission at the same time, also are susceptible to emotional interference in the same manner.

Similarly, the review in chapter 3 implies that the analyzing and interpretation of informational cues in man-machine settings may also be affected by emotional stress. Several of the reports reviewed suggest that much of intellectual performances is impaired during stressful conditions, particularly if the task is complex and requires creativity, flexibility, or some form of cognitive restructuring. However, it is also suggested by Broverman et al. (1974) that the performance of tasks that are serial, repetitive and over-learned, may even be improved by short-term stress, at least if the stress does not become too intense. Furthermore, the results by Dittes (1961), and Smock (1955 a, b), also suggest that emotional stress may result in a decreased tolerance of ambiguity. Thus, emotional stress produces a pull toward consistent and rigid processing, ignoring more inconsistent cues.

How emotions interfere with the analyzing, interpreting or restructuring properties of cognitive processing is hard to describe in more detail. It is probably also here a question of reallocation of cognitive capacity toward the threat, and consequently more simple and little demanding cognitive strategies are left for the analysis of information from the machine setting. It is also probable that the criteria dealing with what is judged as important to take care of, may be changed. For example, let us once again cite the study of Wright (1974), who found that subjects were more inclined to attend to cues that were related to possible negative outcomes of a simulated decision task, than to cues related to possible positive gains, as a function of stress. The proposals by Welford (1973) and the results of Simonov et al. (1977) also suggest that the increased rate of "false alarms" may indicate some form of changed criteria or cut-off points, i.e. subjects become biased and interprete noise as figure to a greater extent.

For man-machine systems this implies that system performance, requiring complex, flexible and restructuring means of interpreting ana analyzing information, should be very susceptible to stress, particularly if the criteria are not concrete and straightforwardly stated.

In turning to the last sequential step of man's duties in a man-machine system, namely to decide and execute some proper actions in the system, there is also found several reports that indicate interference from emotional arousal. Particularly it is suggested that decisions made under emotional influence are more impulsive, definitive and premature. Subjects' decisions may be characterized as more impulsive and premature while they seem to be based on more premature and ill-considered hypotheses. By definitiveness is meant the tendency to make overly consistent and rigid responses in a "black-and-white" manner. These tendencies are probably also consequences of less cognitive efficiency allocated to the task in question, and changes in the usage of the criteria pertaining to what a proper action may be. Consider for example the soldier, who in a battle may be satisfied just to shoot in the right direction, while the same soldier under training may be utterly dissatisfied if not receiving a shooting medal.

Consequently, man-machine systems, that require the operator to make well-considered, subtle and carefully made decisions, seem to be prone to function worse under emotional arousal, probably even so when the criteria pertaining to what is the most proper action are loosely defined.

One further important factor in the smooth execution of action in many machine settings is well coordinated and subtle sequencies of motor muscle activity (LeGarde, Lubman, & Hartnett, 1971; Drinkwater, Flint, & Clelland, 1968). Take for example the case of driving on a slippery road. Under such circumstances it is important to be very careful in braking and steering the car. Despite this it is very common that drivers in cases of emergency panicly brake or steer with very hard and drastic movements in a crude manner. Thus, it seems to be very difficult to execute well-coordinated and smooth motor activities in stressful conditions, due to the increased bodily tension.

Finally, in chapter 3 studies were referred to that showed that emotional stress may result in a tendency toward adhering to cognitive actions that, via learning, have become the most established ones. This means that an operator may regress to habitual or first-learned modes of action in cases of emotional arousal. Consequently, the functioning in man-machine systems, characterized by frequent changes in the requirements on the operator, may be impaired as a function of arousal.

To summarize very briefly, the effects on the efficiency of man-machine systems as a function of emotional arousal in the operator, it is proposed that the operator's cognitive efficiency in the setting is directed to the most central, immediate and crude modes of action. And this occurs in all sequential steps of information processing, i.e. attentional, analyzing, and executing acts. Furthermore, this may be explained both in terms of less cognitive capacity left for information processing, and in terms of changes in criteria.

Following this, a very natural point of question is to discuss possible means of reducing the influence of interfering emotional stress on efficiency of man-machine systems.

6.6 How to eliminate emotional interference in man-machine systems

An extensive discussion on how to eliminate dysfunctional emotions in general was given above. And there is no reason why these suggestions should not be possible to apply also to man-machine systems. But, of the proposals made on page the most plausible factors in this case is probably point (3) to (6), because the other two are more related to earlier psychological development and more "deep-rooted" in individual and societal characteristics.

Thus, the following strategies may decrease the interference of emotional states in the operator:

(1) A high value to run the system as effectively as possible.

(2) Realistic and appropriate judgments about the occurrence and implications of potential threatening stimuli, and potential coping resources.

(3) Anticipatory knowledge of subjective reactions to threat.

(4) A repertoire of appropriate coping strategies:
   (a) concrete action routes for the elimination of the threat;
   (b) cognitive coping strategies;
   (c) techniques of relaxation.

These strategies may involve selection of operators, training and the acquisition of proper coping techniques.

Furthermore, it is also plausible that the general cognitive capacity of the operator may be an important factor in this case. Thus, the more information an individual can handle simultaneously and the quicker he becomes "automatized" in the task, the smaller is probably the interference of emotional strain (Easterbrock, 1959; Jennings & Chiles, 1977; North & Gopher, 1976). This capacity may be obtained primarily via selection, but probably sometimes also via intensive training.

Some remarks can also be stated pertaining to the character of such training. According to Broverman et al. (1974), it is suggested that operations should be trained intensively so that they become over-learned. In such cases performance becomes less influenced by emotional arousal.

One further way of optimizing effectiveness of man-machine systems is a suitable design of the system. In fact, the general principles for such designs have already indirectly been stated, but let us make a final summary:

(1) The principle of "centrality" should guide the designatio of informational input, which in more concrete terms may denote that:
   (a) the operator has only one central task to attend to;
   (b) the operator should not have to switch from one mode of informational scanning toward another;
   (c) the informational input should be reduced to only relevant ones for the task;

   (d) the informational input should physcially be placed in front of the operator;

   (e) the informational input should be clear, concrete, physically outstanding and of less complexity.

(2) The requirements of cognitive capacity in the operators should be minimized. This may indicate that:

   (a) information should be possible to analyze by means of simple and crude cognitive strategies;

   (b) small requriements should be made on flexible and restructuring capacities in the operator.

(3) The system should "allow" the operator to make rapid decisive acts, based on a minimum of deliberation. This may indicate that the information should be given in a clear and straight-forward manner so that no subtle and overly well-considered decisions have to be made.

(4) The requirements of well-coordinated and subtle motor activities should be minimized as well.

(5) Technical and requiremental changes in the systems should be minimized, thus decreasing the possibilities for the operator to regress to habitual actions in cases of emotional stress.

(6) And, finally, the criteria pertaining to what to attend to, how to analyze, and what to do, should be defined in a clear manner, thus encouraging the operator to clearly evaluate the appropriateness of a chosen action.

The depicted man-machine system probably is a very boring and ineffective system under non-emotional conditions. Definitely, this may indicate a problem, but it may also indicate that the principles of designing an optimal system should be different, depending on which emotional conditions it has to be effective. Computer technology may make it possible to design systems which function in different modes depending on whether the conditions are likely to be emotionally prvocative (crisis) or not. In the latter case the operator may well need much cognitive stimulation in order not to be bored and less vigilant.

Finally, some general comments should be made on further research. Firstly, it is important to theoretically incorporate the concepts of emotion and motivation into the general theories and models of human information processing. Secondly, much more research has to be done pertaining the effects of emotion on cognitive processes. Here, there is a need to differentiate effects on processing capacity from effects on decision criteria. Thirdly, the psychological mechanisms in counteracting interfering emotions need much more investigation as well. And fourthly, more knowledge how to train people and properly adjust the demands (for example designation of man-machine systems) for optimal efficiency under emotional circumstances is necessary.

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References

Aborn, M. The influence of experimentally induced failure on the retention of material acquired through set and incidental learning. *Journal of Experimental Psychology*, 1953, *45*, 225-231.

Ainsworth, L. H. Rigidity, insecurity and stress. *Journal of Abnormal and Social Psychology*, 1958, *56*, 67-74.

Andersson, C. R. Coping behavior as intervening mechanisms in the inverted U stress performance relationships. *Journal of Applied Psychology*, 1976, *61*, 30-34.

Arnold, M. B. Stress and emotion. In M. H. Appley & R. Trumbull (Eds.), *Psychological Stress*. New York: Appleton-Century-Crofts, 1967.

Arnold, M. B. Perennial problems in the field of emotion. In M. B. Arnold (Ed.), *Feelings and emotions: The Loyola Symposium*. New York: Academic Press, 1970.

Ax, A. F. The physiological differentiation of fear and anger in humans. *Psychosomatic Medicine*, 1953, *15*, 433-442.

Bacon, S. J. Arousal and the range of cue utilization. *Journal of Experimental Psychology*, 1974, *102*, 81-87.

Baddeley, A. D. Influence of depth on the manual dexterity of free divers: a comparison between open sea and pressure chamber testing. *Journal of Applied Psychology*, 1966, *50*, 81-85.

Baddeley, A. D. Selective attention and performance in dangerous environments. *British Journal of Psychology*, 1972, *63*, 537-546.

Bahrick, H. P. Incidental learning under two incentive conditions. *Journal of Experimental Psychology*, 1975, *47*, 170-172.

Bahrick, H. P., Fitts, P. M., & Rankin, R. E. Effects of incentives upon reactions to peripheral stimuli. *Journal of Experimental Psychology*, 1952, *44*, 400-406.

Barker, R., Dembo, T., & Levin, K. Frustration and regression: an experiment with children. *University of Iowa Studies of Child Welfare*, 1941, *18*, (No. 1).

Barthol, R. P., & Ku, N. D. Regression under stress to first learned behavior. *Journal of Abnormal and Social Psychology*, 1959, *59*, 134-136.

Basowitz, H., Persky, H., Korchin, S. J., & Grinker, R. R. *Anxiety and stress*. New York: McGraw-Hill, 1955.

Beam, J. C. Serial learning and conditioning under real-life stress. *Journal of Abnormal Social Psychology*, 1955, *51*, 543-551.

Beck, A. T. *Cognitive therapy and the emotional disorders*. New York: International Universities Press, 1976.

Becker, S. S., Horowitz, M. J., & Campbell, L. Cognitive responses to stress: Effects of changes in demand and sex. *Journal of Abnormal Psychology*, 1973, *82*, 519-522.

Beier, E. G. The effect of induced anxiety on flexibility of intellectual functioning. *Psychological Monographs*, 1951, *65*, (whole No. 326).

Bem, D. J., Wallach, M. A., & Kogan, N. Group decision making under risk of aversive consequences. *Journal of Personality and Social Psychology*, 1965, *1*, 453-460.

Bergström, B. Psychomotor performance under stress: Studies of human tracking behavior under short-term psychological stress. MPI Report, 1970, 04.22:6.

Berkun, M. M., Bialek, H. M., Kern, R. P., & Yagi, K. Experimental studies of psychological stress in man. *Psychological Monographs*, 1962, 76, (whole No. 534).

Bloom, L. J., Houston, B. K., Holmes, D. S., & Burish, T. G. The effectiveness of attentional diversion and situation redefinition for reducing stress due to a nonambiguous threat. *Journal of Research in Personality*, 1977, *11*, 83-94.

Bowlby, J. Psychopathology of anxiety: the role of affectional bonds. In M. H. Lader (Ed.), *Studies of anxiety*. Ashford: Meadley Bros., 1969.

Bridges, K. M. B. *The social and emotional development of the preschool child*. London: Kegan Paul, 1932.

Brim. O. G., & Hoff, D. B. Individual and situational differences in desire for certainty. *Journal of Abnormal and Social Psychology*, 1958, *22*, 39-44.

Brody, N.N-achievement, test anxiety, and subjective probability of success in risk taking behavior. *Journal of Abnormal and Social Psychology*, 1963, *66*, 413-418.

Bronner, K,, & Levi, L. *Stress i arbetslivet. Medicinska och psykologiska synpunkter på arbetslivets stress.* Stockholm: 1967.

Broverman, D., M., Klaiber, E. L., Kobayashi, Y., & Vogel, W. Roles of activation and inhibition in sex differences in cognitive abilities. *Psychological Review*, 1968, *75*, 23-50,

Broverman, D. M., Klaiber, E. L., Vogel, W., & Kobayashi, Y. Short-term versus long-term effects of adrenal hormones on behavior. *Psychological Bulletin*, 1974, *81*, 672-694.

Bruner J. S., & Goodman, C. C. Value and need as organizing factors in perception. *Journal of Abnormal and Social Psychology*, 1947, *42*, 33-44.

Bruner, J. S., Matter, I., & Papanek, M. L. Breadth of learning as a function of drive level and mechanization. *Psychological Review*, 1955, *62*, 1-10.

Bruner, J. S., & Postman, L. Emotional selectivity in perception and reaction. *Journal of Personality*, 1947, *16*, 69-77.

Bursill, A. E. The restriction of peripheral vision during exposure to hot and humid conditions. *Quarterly Journal of Experimental Psychology*, 1958, *10*, 113-129.

Callaway, E., & Thompson, S. V. Sympathetic activity and perception. *Psychosomatic Medicine*, 1953, *15*, 443-455.

Cannon, W. B. The James-Lange theory of emotion: a critical examination and an alternative theory. *American Journal of Psychology*, 1927, *39*, 106-124.

Carlzon, V. R., & Lazarus, R. S. A repetition of Meyer Williams' study of intellectual control under stress and associated Rorschach factors. *Journal of Consulting Psychology*, 1953, *17*, 247-253.

Castaneda, A., & Palermo, D. S. Psychomotor performance as a function of amount of training and stress. *Journal of Experimental Psychology*, 1955, *5*, 175-179.

Chapanis, R. Accuracy of oral trnsmission of target information. Systems Res. Field Lab. (Jamestown), Memo. Rep. 1964.

Chiles, W. D. Effects of shock induced stress on verbal performance. *Journal of Experimental Psychology*, 1958, *56*, 159-165.

Child, I. L. Personality. *Annual Review of Psychology*, 1954, *5*, 149-170.

Chodoff, P. The German concentration camp as a psychological stress. *Archives of General Psychology*, 1970, *22*, pp. 78-87.

Chodoff, P., Friedman, S. B., & Hamburg, D. A. Stress, defenses, and coping behavior: Observations of children with malignent disease. *American Journal of Psychiatry*, 1964, *120*, pp. 743-749.

Cobb, B. C., Clark, R. L., Jr., McGuire, C., & Hawe, C. D. Patient-responsible delay of treatment of cancer: A social psychological study. *Cancer*, 1954, *7*, 920-926.

Cofer, C. N., & Appley, M. H. *Motivation: Theory and research*. New York: Wiley, 1964.

Conrad, R. Speed and load stress in a sensory-motor skill. Applied Psychological Research Unit, Cambridge, 1950, APV 134/50.

Cowen, E. L. The influence of varying degrees of psychological stress on problemsolving rigidity. *Journal of Abnormal and Social Psychology*, 1952, *20*, 65-68. (a)

Cowen, E. L. Stress reduction and problemsolving rigidity. *Journal of Consulting Psychology*, 1952, *16*, 425-428. (b)

Cramond, W., & Aberd, D. Psychological aspects of uterine disfunction. Lancet, 1954, 2, 1241-1245.

Crawford. A. Fatigue and driving. Ergonomics, 1961, 4, 143-154.

Cumming, R. W., & Croft, P. G. Human information processing under varying task demand. In A. T. Welford (Ed.), Man under stress. London: Taylor & Francis, 1974.

D'Amato, M. R., & Gumenik, W. E. Some effects of immediate versus randomly delayed shock on an instrumental response and cognitive processes. Journal of Abnormal and Social Psychology, 1960, 60, 64-67.

Darwin, C. R. The expressions of emotions in man and animal. London: Murray, 1872.

Davidson, W. Z., Andrews, T. G., & Ross, S. Effects of stress and anxiety on continuous high-speed color naming. Journal of Experimental Psychology, 1965, 52, 13-17.

Davis, D. R. Pilot error. Air publication 3139A. London: Her Majesty's Stationary Office, 1948.

Davitz, J. R. The language of emotion. New York: Academic Press, 1969.

Dittes, J. E. Impulsive closure as reaction to failure induced threat. Journal of Abnormal and Social Psychology, 1961, 63, 562-569.

Drinkwater, B. L., Flint, M, M., & Cleland, T. S. Somatic responses and performance levels during anticipatory physical threat stress. Perceptual and Motor Skills, 1968, 27, 539-552.

Drwal, R. L. The influence of psychological stress upon creative thinking. Polish Psychological Bulletin, 1973, 4, 125-129.

Duffy, E. Activation and behavior. New York: Wiley, 1962

Easterbrook, J. A. The effect of emotion on cue utilization and the organization of behavior. Psychological Review, 1959, 66, 183-201.

Erdelyi, M. H. A new look at the new look: perceptual defense and vigilance. Psychological Review, 1974, 81, 1-25.

Erdelyi, M. H., & Appelbaum, A. G. Cognitive masking: the disruptive effect of an emotional stimulus upon the perception of continuous neutral items. Bulletin of the Psychonomic Society, 1973, 1, 59-61.

Eysenck, H. J. Psychological aspects of anxiety. In M. H. Lader (Ed.), Studies of anxiety. Ashford: Headley Bros., 1969.

Eysenck, H. J., Granger, G. W., & Brenglemann, J. C. *Perceptual processes and mental illness*. London: Chapman and Hall, 1957.

Fanconi, G., & Ferrazzini, F. Kogenitale Analgie: Kongenitale generalisierte schmerzindifferenz. *Helvetia Paediatrica Acta*, 1957, *12*, 79-115.

Feather, N. T. Effects of prior success and failure on expectations and subsequent performance. *Journal of Personality and Social Psychology*, 1966, *3*, 287-298.

Fenz, W. D. Conflict and stress as related to physiological activation and sensory perceptual and cognitive functioning. *Psychological Monographs*, 1964, *78*, (whole No. 585).

Frijda, N. H. Emotion and recognition of emotion. In M. L. Arnold (Ed.), *Feelings and emotions: The Loyola Symposium*. New York: Academic Press, 1970.

Fritz, C. E., & Marks, E. S. The whole NORC studies of human behavior in disaster. *Journal of Social Issues*, 1954, *10*, 25-41.

Fry, G. A. The relation of accomodation to the suppression of vision in one eye. *Americal Journal of Ophthalmology*, 1936, *19*, 135-138.

Gardner, R. W., Holzman, P. S., Klein, G. S., Lintne, H., & Spence, D. Cognitive control: A study of individual consistencies in cognitive behavior. *Psychological Issues*, 1959, *1*, No. 4.

Gellhorn, E. Motion and emotion: The role of proprioception in the physiology and pathology of the emotions. *Psychological Review*, 1964, *71*, 457-472.

Gellhorn, E., & Loutbourrow, G. N. *Emotions and emotional disorders*. New York: Hoeler, 1963.

Girodo, M., & Roehl. J. Preparatory information and self-talk in coping with the stress of flying. Unpublished manuscript, University of Ottawa, 1976.

Goldstein, M. J. Individual differences in response to stress. *American Journal of Community Psychology*, 1973, *1*, 113-137.

Goldstein, M. J., Jones, R. B., Clemens, T. L., Flagg, G. W., & Alexander, F. G. Coping style as a factor in psychophysiological response to a tension-arousing film. *Journal of Personality and Social Psychology*, 1965, *1*, 270-280.

Grinker, R. R., & Spiegel, J. P. *Men under stress*. Piladelphia: Blakiston, 1945.

Grinker, R. R., Willerman, B., Bradley, A., & Fastovsky, A. A study of psychological predisposition to the development of operational fatigue, 1 and 2. *American Journal of Orthopsychiatry*, 1946, *16*, 191-214.

Hancock, J. G., & Teevan, R. C. Fear of failure and risk-taking behavior. Journal of Personality, 1964, 32, 200-209.

Hare, R. D. Denial of threat and emotional response to impending painful stimulation. Journal of Consulting Psychology. 1966, 30, 359-361.

Harleston. B. W. Test anxiety and performance in problem-solving situations. Journal of Personality, 1962, 30, 557-573.

Harleston, B. W., Smith, M. G., & Arey, D. Test-anxiety level, heart rate, and anagram problem solving. Journal of Personality and Social Psychology, 1965, 1, 551-557.

Hebb, D. O. Psykologi på biologisk grund. Lund: Gleerups, 1969.

Heimstra, N. W. The effects of stress fatigue on performance in a simulated driving situation. Ergonomics, 1970, 13, 209-218.

Hess, E. H. Attitude and pupil size. Scientific American, 1965, 212, 46-54.

Hess, E. H., & Polt, J. Pupil size as related to interest value of visual stimuli. Science, 1960, 132, 349-350.

Hockey, G. R. J. Effect of loud noise on attentional selectivity. Quarterly Journal of Experimental Psychology, 1970, 22, 28-36.

Hockey, G. R. J. Changes in information-selection patterns in multisource monitoring as a function of induced arousal shifts. Journal of Experimental Psychology, 1973, 101, 35-42.

Hohmann, G. W. Some effects of spinal cord lesions on experienced emotional feelings. Psychophysiology, 1966, 3, 143-156.

Holmes, D. S., & Houston, B. K. Effectiveness of situation redefinition and affective isolation in coping with stress. Journal of Personality and Social Psychology, 1974, 29, 212-218.

Holzman, P. S. Repression and cognitive style. Bulletin of the Menninger Clinic, 1962, 26, 273-282.

Holzman, P. S., & Gardner, R. W. Leveling and repression. Journal of Abnormal and Social Psychology, 1959, 59, 151-155.

Horowitz, M. J., & Wilner, N. Stress films, emotion and cognitive response. Archives of General Psychiatry, 1976, 33, 1339-1344.

Houston, B. K. Viability of coping strategies, denial and response to stress. Journal of Personality, 1973, 41, 50-58.

Houston, B. K. Dispositional anxiety and the effectiveness of cognitive coping strategies in stressful laboratory and classroom situations. In C. D. Spielberger & I. G. Sarason (Eds.), Stress and anxiety (Vol. 4). New York: Hemisphere/Wiley, 1977.

Hutchinson, V.Q., & Cotten, D. J. Effects of audience and anxiety level on learning and performance of a complex gross motor skill by college women. *Perceptual and Motor Skills*, 1973, *36*, 1103-1108.

Hutt, L. D., & Andersson, J. P. Perceptual defense and vigilance: Predicted from the Byrne Scale of Repression-Sensitization. *Psychonomic Science*, 1967, *9*, 473-474. (a)

Hutt, L. D., & Andersson. J. D. The relationship between pupil size and recognition threshold. *Psychonomic Science,* 1967, *9*, 477-478. (b)

Izard, C. E. *Human emotions*. New York: Plenum Press, 1977.

James, W. What is an emotion? *Mind*, 1884, *9*, 188-205.

Janis, I. L. Problems related to the control of fear in combat In S. Stoutter, A. A. Lumsdaine, R. Williams, M. B. Smith, I. L. Janis, S. A. Star, & L. Cottrell, Jr. (Eds.), *The American soldier, Vol. 2. Combat and its aftermath*. Princeton. N.J.: Princeton University Press, 1949.

Janis, I. L. *Psychological stress*, New York: Wiley, 1958.

Janis, I. L. *Stress and frustration*. New York: Harcourt/Brace/Iovanovich, 1971.

Janis, I. L., & Leventhal, H. Psychological aspects of physical illness and hospital care. In B. Wolman (Ed.), *Handbook of clinical psychology*. New York: McGraw-Hill, 1965.

Janis, I. L., & Mann, L. *Decision making: A psychological analysis of conflict choice and commitments*. New York: The Free Press, 1977.

Jennings, A. E., & Chiles, W. D. An investigation of time-sharing ability as a factor in complex performance. *Human Factors*, 1977, *19*, 545 - 547.

Johnson, E. E. The role of motivational strength in latent learning. *Journal of Comparative and Physiological Psychology*, 1952, *45*, 526-530.

Katchmar, L. T., Ross, S., & Andrews, T. G. Effects of stress and anxiety on perfomrance of a complex verbal coding task. *Journal of Experimental Psychology*, 1958, *55*, 559-564.

Kohn, H. Effects of variations of intensity of experimentally induced stress situations upon certain aspects of perception and performance. *Journal of Genetic Psychology*, 1954, *85*, 289-304.

Korchin, S. J., & Basowitz, H. Perceptual adequacy in a life stress. *Journal of Psychology*, 1954, *38*, 495-502.

Kragh, U. The defensive mechanism test (DMT) as a method for diagnosis and personell selection. In U. Kragh & G. Smith (Eds.), *Percept-genetic analysis*, Lund: Gleerups, 1970.

Kragh, U., & Smith, G. (Eds.), *Percept-genetic analysis*. Lund: Gleerups, 1970.

Lack, L. C. The role of accomodation in the control of binocular rivalry. Perception & Psychophysics, 1971, 10, 38-42.

Lantz, B. Some dynamic aspects of success and failure on the recall of tasks. Psychological Monographs, 1945, 59, (whole No. 271).

Lazarus, R. S. Psychological stress and the coping process. New York: McGraw-Hill, 1966.

Lazarus, R. S., Deese, J., & Osler, S. F. Effects of psychological stress upon performance. Psychological Bulletin, 1952, 49, 293-317.

Lazarus, R. S., Opton, E. M., Nomikos, M. S., & Rankin, N. O. The principle of short-circuiting of threat. Journal of Personality, 1965, 33, 622-635,

Leeper, R. W. A motivational theory of emotion to replace emotion as disorganized response. Psychological Review, 1948, 55, 5-21.

Leeper, R. W. The motivational and perceptual properties of emotions as indicating their fundamental character and role. In M. B. Arnold (Ed.), Feelings and emotion: The Loyola symposium.New York: Academic Press, 1970.

LeGarde, I. C., Lubman, M. V., & Hartnett, I. I. A highway safety "scare" film and its effects on performance and mood of males and females. Behavioral Research in Highway Safety, 1971, 2, 83-97.

Lewin, K. Resolving social conflicts: selected papers on group dynamics. In G.W. Lewin (Ed.). New York: Harper, 1948.

Lieblich, A. The effects of stress and the motivation to succeed on a test-risk. Journal of Personality, 1968, 36, 608-615. (a)

Lieblich, A. Effects of stress on risk taking.Psychonomic Science, 1968, 10, 303-304. (b)

Lindsley, D. B. Emotion. In S. S. Stevens (Ed.), Handbook of experimental psychology, New York: Wiley, 1951.

Lindsley, D. B. The role of nonspecific reticulo-thalamocortical systems in emotion. In P. Black (Ed.), Physiological correlates of emotion. New York: Academic Press, 1970

Lipsett, L. P., & Lolardo, V. M. Interactive effect of stress stimulus generalization on children's oddity learning. Journal of Experimental Psychology, 1963, 66, 210-214.

Luborsky, L., Blinder, B., & Schimek, J. Looking, recalling and GSR as a function of defence. Journal of Abnormal Psychology. 1965, 70, 270-280.

Luborsky, L., & Sharin, H. Forgetting of tachistoscopic exposures as a function of repression. Perceptual and Motor Skills, 1964, 18, 421-436.

Lucas, I. D. The interactive effect of failure,and intraserial duplication. American Journal of Psychology, 1952, 65, 59-66.

Macworth, N. M, Some recent studies of human stress from a marine and naval viewpoint. Inst. of Marine Engrs. Trans., London, 1952, Vol. 64, No. 6.

Mandler, G. Mind and emotions. New York: Wiley, 1975.

Malmo, R. B. Activation: A neuropsychological dimension. Psychological Review, 1959, 66. 367-386.

Mandler, G., & Sarason, S. B. A study of anxiety and learning. Journal of Experimental Psychology, 1952, 47, 166-173.

Marquart, D. I. The pattern of punishment and its relation to abnormal fixation in adult human subjects. Journal of General Psychology, 1948, 39, 107-144.

Maslow, A. H. Toward a psychology of being, Princeton, N.J.: Van Nostrand, 1962.

McArthur, W. J., & Haakonson, N. H. Epidemiology of military air display accidents, Aviation, Space, and Environmental Medicine, 1977, 48, 911-815.

McClelland, D. C., & Apicella, F. S. Reminiscence following experimentally induced fialure. Journal of Experimetnal Psychology, 1947, 37, 101-116.

McGinnies, E. Emotionality and perceptual defence. Psychological Review, 1949, 56, 244-251.

McGrath, J. E. A conceptual formulation for research on stress. In J. E. McGrath, (Ed.), Social and Psychological factors in stress, New York: Holt, Rinehart & Winston, 1970.

McKinney, F., Strother, G. B., Hines, R. R., & Alley, R. A. Experimental frustration in a group test situation. Journal of Abnormal and Social Psychology, 1951, 46, 316-323.

McNair, D. M., Lorr, M., & Droppleman, L. F. Profile of mood states. San Diego, California:Educational and Industrial Testing Service, 1971.

Meddis, R. Bipolar factors in mood adjective checklists. British Journal of Social and Clinical Psychology, 1972, 11, 178-184.

Meichenbaum, D. H. Cognitive modification of test anxious college students. Journal of Consulting and Clinical Psychology, 1972, 39, 370-380.

Meichenbaum, D. H., & Cameron, R. An examination of cognitive and contingency variables in anxiety relief procedures. Unpublished Manuscript, University of Waterloo, Ontario, Canada, 1973.

Miller, G. A. The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, 1956, *63*, 81-97.

Miller, G. A., Galanter, E. H., & Pribram, K. H. *Plans and the structure of behavior*. New York:Rinehart & Holt, 1960.

Millenson, J. R. *Principles of behavioural analysis*. New York: MacMillan, 1967.

Moffit, I. W., & Stagner, R. Perceptual rigidity and closure as functions of anxiety. *Journal of Abnormal and Social Psychology*, 1956, *52*, 354-357.

Montague, E. K. The role of anxiety in serial role learning. *Journal of Experimental Psychology*, 1953, *45*, 91-95.

Montgomery, H., & Svensson, O. On decision rules and information processing strategies for choices among multiattribute alternatives. *Scandinavian Journal of Psychology*, 1976, *17*, 283-291.

Morris, L. W., & Liebert, R. M. Relationships of cognitive and emotional components of test anxiety to physiological arousal and academic performance. *Journal of Consulting and Clinical Psychology*, 1970, *35*, 332-337.

Murphy, R. E. Effects of threat of shock, distraction, and task design on performance. *Journal of Experimental Psychology*, 1959, *58*, 135-141.

Neufeld,R. W. J. The effect of experimentally altered cognitive appraisal on pain tolerance. *Psychonomic Science*, 1970, *20*, 106-107.

Neuman, T.Dimensionering och validering av percept-genesens försvarsmekanismer. FOA rapport, C 55020-M6, oktober, 1978.

North, R. A., & Gopher. D. Measures of attention as predictors of flight performance. *Human Factors*, 1976, *18*, 1-14.

Nowlis, V. The concept of mood. In S.M. Farber & R.M.L. Wilson (Eds.), *Conflict and creativity*. New York: McGraw-Hill, 1963.

Nowlis, V. Mood: Behavior and experience. In M. B. Arnold (Ed.), *Feelings and emotion: The Loyola Symposium*. New York: Academic Press, 1970.

Nowlis, V., & Nowlis, M. H. The description and analysis of mood. Annals of the New York Academy of Science, 1956, 65, 345-355.

Oliver, G., & Griffith, W. Emotional arousal and "objective" judgment. Bulletin of the Psychonomic Society, 1976, 8, 399-400.

Osler, S. F. Intellectual performance as a function of two types of psychological stress. Journal of Experimental Psychology, 1954, 47, 115-121.

Palermo, D. S. Proactive interference and facilitation as a function of amount of training and stress. Journal of Experimental Psychology, 1957, 53, 293-296.

Patrick, J. R. Studies in rational behavior and emotional excitement: III The effect of emotional excitement on rational behavior in human subjects. Journal of Comparative Psychology, 1934, 18, 153-195.

Paul, G. L., & Eriksen, G. W. Effects of test anxiety on "real life" examinations. Journal of Personality, 1964, 32, 480-494.

Plutchik, R. Emotions, evolution and adaptive processes. In M. B. Arnold (Ed.), Feelings and emotions: The Loyola Symposium. New York: Academic Press, 1970.

Postman, L., & Bruner, J. S. Perception under stress. Psychological Review, 1948, 55, 314-323.

Postman, L., Bruner, J. S., & McGinnies, E. Personal values as selective factors in perception. Journal of Abnormal and Social Psychology, 1953, 48, 215-224.

Poulton, E. C. Environment and human efficiency. Springfield, Ill.: Thomas, 1970.

Pribram, K. H. Feelings as monitors. In M. B. Arnold (Ed.). Feelings and emotion: The Loyola Symposium. New York: Academic Press, 1970.

Pronko, N. E., & Leith, W. R. Behavior under stress: A study of its disintegration. Psychological Reports, 1956, 2, 205-222 (Monograph supplement No. 5).

Ramond, C. K. Anxiety and task as determiners of verbal performance. Journal of Experimental Psychology. 1953, 46, 120-124.

Ray, W. S. Mild stress and problem solving. Americal Journal of Psychology, 1965, 78, 227-323.

Renner, J., & Renner, V. Effects of stress on groups versus individual problem solving. Psychological Reports, 1972, 30, 487-419.

Ross, B. M., Rupel, J. W., & Grant, D. A. Effects of personal, impersonal and physical stress upon cognitive behavior in a card sorting problem. Journal of Abnormal and Social Psychology, 1952, 47, 546-551.

Russel, J. A., & Mehrabian, A. Evidence for a three-factor theory of emotions. Journal of Research in Personality, 1977, 11, 273-294.

Russel, D. G., & Sarason, I. G. Test anxiety, sex, and experimental conditions in relation to anagram solution. Journal of Personality and Social Psychology, 1965, 1, 493-496.

Sanders, G. S., & Baron, R. S. The motivationg effects of distraction on task performance. Journal of Personality and Social Psychology, 1975, 32, 956-963.

Sarason, I. G. The effects of anxiety, reassurance, and meaningfulness of material to be learned in verbal learning. Journal of Abnormal and Social Psychology, 1958, 56, 339-344.

Sarason, I. G. Relationships of measures of anxiety and experimental instructions to word association test performance. Journal of Abnormal and Social Psychology, 1959, 59, 37-42.

Sarason, I. G. The effects of anxiety and threat on solution of a difficult task. Journal of Abnormal and Social Psychology, 1961, 62, 165-168.

Sarason, I. G. Test anxiety and cognitive modelling. Journal of Personality and Social Psychology, 1973, 28, 58-61.

Schacter, S. The assumption of identity and peropherilist-centralist controversies in motivation and emotion. In M. B. Arnold (Ed.), Feelings and emotion: The Loyola Symposium. New York: Academic Press, 1970.

Schachter, S., & Singer, J. Cognitive, social and physiological determinants of emotional state. Psychological Review, 1962, 69, 378-399.

Schlosberg, M. Three dimensions of emotion. Psychological Review, 1954, 61, 81-88.

Schultz, L. S. Effects of high-priority events on recall and recognition of other events. Journal of Verbal Learning and Verbal Behaviour, 1971, 10, 322-330.

Seligman, M. E. P. Helplessness. San Fransisco: Freeman, 1975.

Selye, M. The physiology and pathology of exposure to stress. Montreal: Acta Inc., 1950.

Shepard, A. H., & Abbey, D. S. Manifest anxiety and performance on a complex perceptual-motor task. Perceptual and Motor Skills, 1958, 8, 327-330.

Silverman, R. E. Anxiety and the mode of response. *Journal of Abnormal and Social Psychology*, 1954, *49*, 538-542.

Silverman, R. E., & Blitz, B. Learning and two kinds of anxiety. *Journal of Abnormal and Social Psychology*, 1956, *53*, 301-303.

Simon, H. A. Motivational and emotional controls of behavior. *Psychological Review*, 1967, *74*, 29-39.

Simonov, P. V. The information theory of emotions. In M. B. Arnold (Ed.), *Feelings and emotions*:The Loyola Symposium. New York: Academic Press, 1970.

Simonov, P. V. Neural and neurohumoral organization of motivational behaviour. *Proceedings of the fourth conference of interbrain, held in Pécs, Hungary, May, 19-23, 1975*.

Simonov, P. V., Frolov, M. V., Evtushenko, V. F., & Sviridov, E. P. Effect of emotional stress on recognition of visual patterns. *Aviation Space and Environmental Medicine*, 1977, *48*, 856-858.

Sinha, D., & Singh, T. R. Manifest anxiety and performance on problem-solving tasks. *Journal of Consulting Psychology*, 1959, *23*, 469.

Sjöberg, L. Beslutsfattande under emotionell påfrestning. In B. Bergström & J. Palm (Eds.), Man-maskinsymposium i Karlstad 4-6 maj 1977. FOA-rapport A56002-49, november 1977.

Sjöberg, L., & Johnsson, T. Trying to give up smoking: A study of volitional breakdowns. *Göteborg Psychological Reports*, 1976, *6*, No. 13.

Sjöberg, L., & Persson, L-O. A study of attempts by obese patients to regulate eating. *Göteborg Psychological Reports*, 1977, *7*, No. 12.

Sjöberg, L., & Samsonowitz, V. Success and failure in trying to quit smoking. *Göteborg Psychological Reports*, 1977, *7*, No. 8.

Sjöberg, L., Samsonowitz, V., & Olsson, G. Volitional problems in alcohol abuse. *Göteborg Psychological Reports*, 1978, *8*, No. 5.

Sjöberg, L., & Svensson, E. The polarity and dimensionality of mood. *Göteborg Psychological Reports*, 1976, *6*, No. 12.

Smart, R. G. Conflict and conditioned aversive stimuli in the development of experimental neuroses. *Canadian Journal of Psychology*, 1965, *19*, 208-213.

Smock, C. D. The influence of psychological stress on the "intolerance of ambiguity". *Journal of Abnormal and Social Psychology* 1955, *50*, 177-182. (a)

Smock, C. D. The influence of stress on the perception of incongruity. *Journal of abnormal and Social Psychology*, 1955, *50*, 354-356. (b)

Spielberger, C. D. Theory and research on anxiety. In C. D. Spielberger (Ed.), Anxiety and Behavior, New York: Academic Press, 1966.

Speisman. J. C., Lazarus, R. S., Mordkoff, A., & Davison, L. Experimetnal reduction of stress based on ego-defense theory. Journal of Abnormal and Social Psychology, 1964, 68, 367-380.

Stanley-Jones, D. The biological origin of love and hate. In M. B. Arnold (Ed.), Feelings and emotion: The Loyola Symposium. New York: Academic Press, 1970.

Staw, B. M. Knee-deep in the big muddy: A study of escalating commitment to a chosen course of action. Organizational Behaviour and Human Performance, 1976, 16, 27-44.

Steisel, I. M., & Cohen, B. D. The effect of two degrees of failure on level of aspiration and performance. Journal of Abnormal and Social Psychology, 1951, 46, 79-82.

Strelau, J., & Maciejczyk, J. Reactivity and decision making in stress situations in pilots. In C. D. Spielberger & I. G. Sarason (Eds.), Stress and anxiety (Vol. 4). New York: Hemisphere/Wiley, 1977.

Strongman, K. T. The psychology of emotion. London: Wiley, 1973.

Suedfelt, P., Erdelyi, M. H., & Corcoran, C. R. Rejection of input in the processing of an emotional film. Bulletin of the Psychosomatic Society, 1975, 5, 30-32.

Svensson, E. Response format and factor structure in mood adjective check lists. Scandinavian Journal of Psychology, 1977, 18, 71-78.

Svensson, E., Sjöberg, L., & Persson, L-O. The invariance of mood dimensions. Göteborg Psychological Reports, 1977, 7, No. 5.

Taylor, J. A. A personality scale of manifest anxiety. Journal of Experimental Psychology, 1953, 48, 285-290.

Taylor, J. A., & Spence, K. W. The relationship of anxiety level to performance in serial learning. Journal of Experimental Psychology, 1952, 44, 61-64.

Teichner, W. M. Interaction of behavioral and physiological stress reaction. Psychological Review, 1968, 75, 271-291.

Titchner, J., Zweling, I., Gottschalk, L., Levine, M., Silver, M., Cowelt, A., Cohen, S., & Colbertson, W. Consequences of surgical illness and treatment: Interaction of emotions, personality and surgical illness, and treatment, convalescence. Americal Medical Association Archives of Neurology and Psychiatry, 1957, 77, 623-634.

Tomkins, S. S. Affect as the primary motivational system. In M. B. Arnold (Ed.), Feelings and emotion: The Loyola Symposium. New York: Academic Press, 1970.

Usdansky, G., & Chapman, L. J. Schizophreniclike responses in normal subjects under time pressure. *Journal of Abnormal and Social Psychology*, 1960, *60*, 143-146,

Wachtel, P. L. Anxiety, attention and coping with threat. *Journal of Abnormal Psychology*, 1968, *73*, 137-143.

Walker, N. K., & Burkhardt, J. F. The combat effectiveness of various human operator controlled systems. Proc. 17th U.S. Military Operations Research Symposium, 1965.

Watson, J. B. *Psychology. From the standpoint of a behaviourist*. London: B. Lipincott Co., 1929.

Welford, A. T. Stress and preformance. In A. T. Welford (Ed.), *Man under stress*. London: Taylor & Francis, 1974.

Weltman, G., & Egstrom, G. H. Perceptual narrowing in novice divers. *Human Factors*, 1967, *8*, 499-506.

Westheimer, G. Accommodation measurements in empty visual fields. *Journal of the Optical Society of America*, 1957, *47*, 714-718.

Wilner, N., & Horowitz, M. J. Intrusive and repetitive thought after a depressing film. *Psychological Reports*, 1975, *37*, 135-138.

Wine, J. Test anxiety and direction of attention. *Psychological Bulletin*, 1971, *76*, 92-104.

Wolf, S:, & Wolff, M. G. *Human gastric function*. Oxford: Oxford University Press, 1947.

Wright, P. The harassed decision maker: time pressures, distractions and the use of evidence. *Journal of Applied Psychology*, 1974, *59*, 555-561.

Valins, S. Cognitive effects of false heart-rate feedback. *Journal of Personality and Social Psychology*, 1966, *4*, 400-408.

Valins, S. The perception and labeling of bodily changes as determinants of emotional behavior. In P. Black (Ed.), *Physiological correlates of emotion*. New York: Academic Press, 1970.

Verville, E. The effect of emotional and motivational sets on the perception of incomplete pictures. *Journal of Genetic Psychology*, 1946, *69*, 133-145.

Vogel, W., Raymond, S., & Lazarus, R. S. Intrinsic motivation and psychological stress. *Journal of Abnormal and Social Psychology*, 1959, *58*, 225-233.

Yerkes, R. M., & Dodson, J. D. The relation of strength of stimulus to rapidity of habit formation. *Journal of Comparative Neurology and Psychology*, 1908, *18*, 459-482.

Young, P. Motivation and emotion. New York: Wiley, 1961.

Zeller, A. F. An experimental analogue of repression:II. The effect of individual failure and success on memory measured by relearning. Journal of Experimental Psychology, 1950, 40, 411-422.